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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

**In re application of:**

John L. Klocke and Linlin Chen

**Application No.** 10/688,420

**Filed:** October 16, 2003

**Confirmation No.** 2239

**For:** ELECTROPLATING COMPOSITIONS  
AND METHODS FOR  
ELECTROPLATING

**Examiner:** Edna Wong

**Art Unit:** 1753

**Attorney Reference No.** 6884-65576-01

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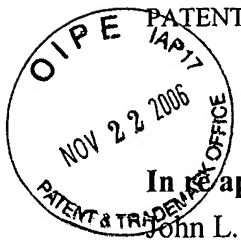
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### **I. Real Party in Interest**

The real party in interest is Semitool, Inc., the assignee of the present application.

### **II. Related Appeals and Interferences**

To the best of appellant's, the appellant's legal representative, and assignee's knowledge, there are no related appeals or interferences.

### **III. Status of Claims**

Claims 1-69 are rejected.

The rejections of claims 1-69 are appealed.

### **IV. Status of Amendments**

An Amendment was filed electronically on November 16, 2006. The Amendment addresses form issues raised in the final Office action as to claims 62 and 65 raised. The Amendment also puts claims 62 and 65 in better form for appeal. The Patent Office had not appeared to have acted upon the filing of the Amendment at the time this Appeal Brief was filed.

## V. Summary of Claimed Subject Matter

In the production of semiconductor integrated circuits, metal layers on a workpiece (such as wafers) are deposited to serve as interconnect metallization that electrically connects various devices on the integrated circuit to one another (p. 1, ll. 10-14).<sup>1</sup> Electrodeposition may be used to deposit the metal layers (p. 2, ll. 17-21).

Electroplating compositions often comprise copper (e.g., copper sulfate) and an acid (e.g., sulfuric acid) (p. 2, ll. 26-27). The acid provides the high ionic conductivity to the plating composition necessary to achieve high throwing power. "Throwing power" refers to the ability of an electroplating composition to deposit metal uniformly on a wafer substrate (p. 2, l. 27 – p. 3, l. 3). If the composition has a low concentration of copper and a high concentration of acid, throwing power of the composition is improved (p. 3, ll. 3-7).

Conventional plating solutions comprise either relatively high acid concentration to low copper concentration ratios *or* low acid concentration to high copper concentration ratios (p. 3, l. 7 – p. 4, l. 25; p. 8, ll. 24-28). There is poor metal filling capability when using a plating composition superior in throwing power and coating uniformity (i.e., high acid to low copper compositions) to fill copper into high aspect ratio features (p. 4, ll. 1-8; p. 8, ll. 24-28). High aspect ratio features refer to the ratio of the depth to width of the interconnect features, e.g., trenches or contact holes (p. 4, ll. 1-8; p. 8, ll. 24-28). But using a conventional low acid, high copper plating composition provides inferior throwing power and suppressed additive activity, resulting in unplated areas within features (p. 4, ll. 8-10; p. 8, ll. 24-28).

Attempts to address the problems introduced using the conventional plating compositions (i.e., compositions having a high acid concentration to low copper concentration of or visa versa) are not satisfactory. Such attempts include the inclusion of additives such as suppressors, accelerators, and/or levelers (p. 4, ll. 23-28).

Applicants, contrary to conventional wisdom, developed compositions including copper and acid at previously avoided relative concentrations. Applicants' compositions have relatively low acid concentrations to relatively low copper concentrations as compared to the prior art (p. 9,

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<sup>1</sup> Please note: Although citations to page and line numbers of the application are provided for support of the summary text herein, those may not be the only place within the specification such items are discussed and are not chosen to carry more or less interpretive weight than other, not cited, mentions in the specification.

ll. 1-3). Put another way, Applicants' compositions have relatively low and narrow acid to copper concentration ratios.

Using comparative testing, Applicants confirmed that their invention provided depositions far exceeding the prior art compositions. Comparative tests are shown in the specification on page 22, line 1 through page 27, line 4. For comparison testing, the prior art electroplating compositions (which notably are almost identical in composition to the art cited in the Office actions against the present claims as discussed below) were tested under the same conditions with identical additives at the identical additives concentrations. The only parameter varied between the currently claimed compositions and the prior art compositions were the relative concentrations of acid to copper (p. 22, ll. 16-17). The test results reported for the compositions claimed having relatively low acid to copper concentration ratios (unlike the high ratios of the prior art) indicate the unexpected superior results of the currently disclosed compositions (p. 22, l. 22 – p. 23, l. 6; p. 23, ll. 7-14; p. 24, l. 4 – p. 25, l. 2 – for ease of reference, these pages are attached hereto as XII Appendix – Comparative Tests as Disclosed in the Specification).

Claimed embodiments of Applicants' electroplating compositions comprise:

an aqueous mixture of copper and sulfuric acid wherein the ratio of copper concentration to sulfuric acid concentration is from about 0.3 to about 0.8  
(p. 9; ll. 4-13)

or

wherein the compositions have certain, relatively narrow acid and copper concentration ranges, for example, about 65 to about 150 g/L acid and about 35 to 60 g/L copper (i.e., a 1.1 to 4.3 acid to copper ratio)  
(p. 9, ll. 21-26)

and other narrower ratio ranges. Certain of Applicants' claimed compositions also comprise:

an aqueous mixture of copper and sulfuric acid wherein the copper concentration is within about 60% to about 90% of its solubility limit when the sulfuric acid concentration is from about 65 to about 150 g/L  
(p. 9; ll. 14-21).

Other compositions of even narrower ranges and relative concentrations of acid to copper are also disclosed (p. 9, l. 8 – p. 10, l. 4) and claimed in certain independent claims. These compositions may also include conventional additives, such as accelerators, suppressors, halides and/or levelers (p. 10, ll. 11-18; p. 11, ll. 4-5; p. 11, ll. 21-22; p. 12, ll. 23-26).

## **VI. Grounds of Rejection to be Reviewed on Appeal**

The following rejections are presented for review (the rejections are set forth as recited in the Final office action dated June 8, 2006):

1. Whether claims 55-62 are properly rejected under 35 USC § 112, first paragraph for allegedly not being enabled.
2. Whether claims 1-5 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857).
3. Whether claims 6-14 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857).
4. Whether claims 15-18 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857).
5. Whether claims 19-25 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857).
6. Whether claims 26-33 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857).
7. Whether claim 34 is obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796).
8. Whether claims 35-43 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857).
9. Whether claims 44-52 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857).



10. Whether claims 53 and 54 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857).
11. Whether claims 55-56, 58, 60 and 62 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Uzoh (US Patent App. No. 2002/0033342).
12. Whether claims 57, 59 and 61 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Uzoh (US Patent App. No. 2002/0033342) and further in view of Basol (US Patent No. 6,833,063).
13. Whether claims 63-65 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857).
14. Whether claims 66-67 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Wilson (US Patent App. No. 2005/0178667).
15. Whether claims 68-69 are obvious under 35 USC § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Wilson (US Patent App. No. 2005/0178667).
16. Whether claims 1-5 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756).
17. Whether claims 6-14 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756).
18. Whether claims 15-18 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756).
19. Whether claims 19-25 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756).

20. Whether claims 26-33 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756).
21. Whether claim 34 is obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964).
21. Whether claims 35-43 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756).
23. Whether claims 44-52 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756).
24. Whether claims 53 and 54 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756).
25. Whether claims 55-62 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Uzoh (US Patent App. No. 2002/0033342) and further in view of Basol (US Patent No. 6,833,063).
26. Whether claims 66 and 67 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Reid (US Patent No. 6,793,796) in combination with Wilson (US Patent App. No. 2005/0178667).
27. Whether claims 68 and 69 are obvious under 35 USC § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Reid (US Patent No. 6,793,796) in combination with Wilson (US Patent App. No. 2005/0178667).

## VII. Argument

1. Rejection of claims 55-62 under § 112, first paragraph for allegedly not being enabled  
*Claims 55-62:*

*a. § 112 Rejections of Claims 55-62 Appear to Simply Be Examiner Oversight*

It appears that the Examiner mistakenly listed these claims as not overcome by the Amendment filed on April 26, 2006, wherein claim 55 was amended to address this issue (the same rejection as raised in relation to claims 63-65, which rejections were overcome by amendment to those claims in the same manner as claim 55 was amended). As this appears to be an oversight, we expect the Examiner will withdraw this rejection in the Examiner's Answer. If not, we will respond with further argument against such rejection in our Reply Brief.

2. Rejection of claims 1-5 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857)

*Claims 1-5:*

*a. The Cited References Only Disclose Broad Ranges and Do Not Teach or Suggest the Narrow Composition Ranges and Ratios Recited in Claims 1-5*

**This is a case of cited references disclosing a genus but not teaching or suggesting the claimed species. The cited arts' disclosure of very broad copper and acid ranges do not teach or suggest the narrowly crafted copper and acid ranges of the claimed compositions. The only disclosed embodiments in the prior art were distinguished in Applicants' specification with comparative evidence showing the unexpected superior results of Applicants' compositions. The Examiner disregards that evidence and makes faulty legal analyses.**

The references cited are Reid USP 6,793,796 and Reid USP 6,024,857 (collectively referred to as "Reid"). These references along with the other art of record, whether considered alone or in combination, do not teach or suggest the electrochemical deposition compositions having the claimed constituent concentration ranges and ratios.

Applicants discovered surprisingly superior results achieved using electrochemical deposition compositions with certain narrowly claimed concentration ranges of acid and copper and carefully selected acid to copper ratios. Using comparative testing, Applicants confirmed that their discovery provided superior depositions, far exceeding the prior art electrochemical deposition compositions. The comparative test data and evidence is set forth in Applicants' specification (pp. 22-26, in Appendix XII and as discussed further below).

Applicants obtained the surprisingly superior results by using its claimed electrochemical deposition compositions having certain, narrow acid and copper concentration ranges and relative ratios. For example, claim 1, in part, recites an electrochemical deposition composition having:

about 65 to about 150 g/L acid and

about 35 to 60 g/L copper

which is a 1.1 to a 4.3 acid to copper concentration ratio. As depicted in the illustrations below, Applicants' claimed compositions, contrary to the conventional wisdom and the cited prior art, have relatively low acid to copper concentration ratios.

The Reid references primarily disclose broad ranges:

sulfuric acid = 0 - 300 g/L and

copper = 10 - 60 g/L,

which the Examiner relies on to reject the presently claimed compositions ('796 patent c. 7, ll. 52-53). The Reid references disclose the very broad acid to copper ratio of 0 to 30 ('796 patent c. 7, ll. 52-53).

*b. Reid's Only Teachings are Well Outside the Ranges and Ratios Recited in Claims 1-5*

The only teaching of or guidance for making compositions in the Reid reference teach the conventional wisdom of high acid to low copper concentration ratios. Specifically, the Reid references disclose only two examples or specific compositions:

175 g/L acid to 17.5 g/L copper (a 10 to 1 acid to copper ratio)

('796 patent at Table 2)

and

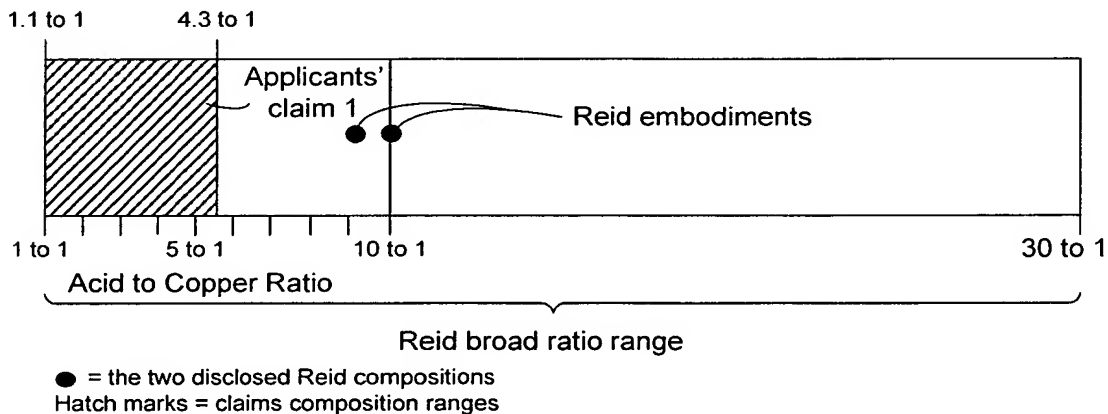
170 g/L acid to 18 g/L copper (a 9.4 to 1 acid to copper ratio)

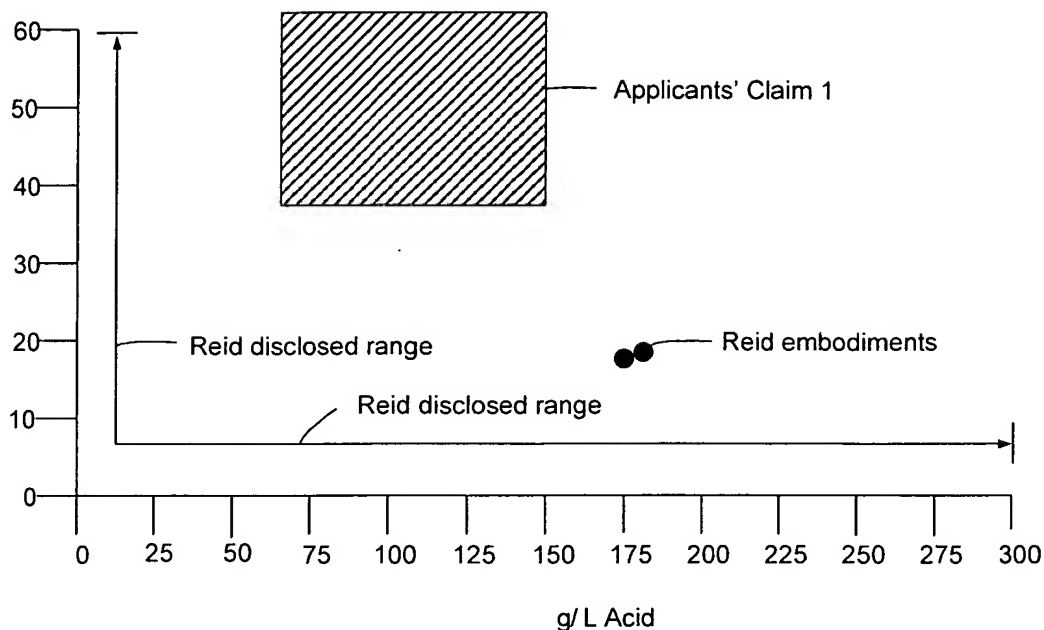
('857 patent c. 3, l. 33-38 and Examples 1-3).

*c. Reid's Only Teachings are for Compositions Having Concentrations and Ratios Far Outside the Claimed Ranges and Ratios*

The below graphs aid in understanding:

- (1) how broad the Reid acid and copper concentration ranges are as compared to Applicants' narrowly claimed composition ranges and ratios, and
- (2) how far the Reid teachings of possible composition embodiments are outside of Applicants' claimed narrow concentration ranges and acid to copper ratios. Applicants' acid and copper concentrations (as claimed in claims 1-5) and acid to copper ratios are shown with hatch marks. The full scale for the bar graph and the chart is equal to the broad ranges disclosed by Reid. The two Reid embodiments are shown with bullet points.





65 to 150 acid and 35 to 60 Cu are the claimed compositions  
175 acid to 17.5 Cu and 180 acid to 18 Cu are the Reid compositions

Neither of the Reid references with their broadly disclosed ranges (nor the other art of record), whether considered alone or in combination, teach or suggest the electrochemical deposition compositions having the claimed narrow constituent concentration ranges and relative ratios. On the contrary, the only teachings set forth in the Reid references are two example compositions having essentially the same (high) acid-to-copper ratios distinguished by Applicants' comparative data. In other words, the cited arts' embodiments were distinguished in Applicants' specification with comparative evidence showing the unexpected superior results of Applicants' compositions.

*d. The Comparison Data Show Reid's Acid and Copper Concentrations and Ratios to be Significantly Inferior to Applicants' Acid and Copper Concentrations and Ratios*

The Reid compositions are almost identical to the very prior art that Applicants' specification and comparative test data distinguished as inferior to Applicants' claimed

compositions. Reid embraces the conventional wisdom of high acid to low copper concentration ratios i.e., a 10 to 1 acid to copper ratio ('796 patent).<sup>2</sup>

- e. Applicants' Comparative Test Data Show the Poor Results Obtained with Compositions Having Acid and Copper Concentrations Virtually Identical to the Only Compositions Taught by Reid*

**Applicants' test data compare Applicants' acid and copper compositions to the prior art acid and copper compositions.** For example, Applicants conducted tests to compare prior art compositions having 180 g/L acid and 20 g/L copper (a 9:1 acid to copper ratio – like the Reid references) as compared to Applicants' relatively low acid to copper ratio composition of, e.g., 80 g/L acid and 50 g/L copper (a 1.6 acid to copper ratio as recited in claim 1) (Spec. p. 23, ll. 7-14; Figs. 5(a) and 5(b)). For comparison purposes, prior art electroplating deposition compositions and Applicants' compositions were tested under the same conditions with identical additives at identical additive concentrations (Spec. p. 22, ll. 17-18). *The only variable in the compositions tested were the different acid and copper concentrations (and hence, the relative acid to copper ratios).*

When using the prior art compositions the results were a copper fill having unacceptable voids (see, e.g., Spec. p. 24, ll. 11-14; Fig. 6(a)). The claimed compositions gave far superior deposition fill results (see, Spec. pp. 22-26 and the corresponding SEM photographs/figures, as reproduced in Appendix XII herein). The comparison data thus clearly rebuts any *prima facie* case the Examiner alleges exists based on the broadly disclosed acid and copper ranges in the cited references.

- f. Based on a faulty factual and legal analysis the Examiner disregards the extensive comparative evidence that distinguishes the art of record and rebuts the prima facie case of obviousness*

The Examiner essentially acknowledges that Applicants' claimed compositions having the narrowly recited acid to copper concentration ranges are different from the two taught

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<sup>2</sup> With the '857 Reid patent disclosing basically the same – specifically, (Examples 1-3 at c. 5 - c. 6) having an acid concentration of 170 g/L and a copper concentration of 18 g/L or a 9.4 to 1 ratio.

compositions in Reid (Office action dated 6/8/2006, pp. 3-7). The Examiner also apparently concedes that the *relative acid and copper concentrations are critical* for providing electrochemical deposition compositions that will adequately plate sub-micron sized integrated circuit device features. Specifically, the Examiner states that "the copper and acid concentrations are not the sole criticality" indicating the Examiner understands that these concentration ranges are indeed critical (Office action dated June 8, 2006, page 3).

*g. The Examiner's Legal Analysis is Incorrect and Actually Proves that Applicants' Claimed Compositions are Not Obvious*

First, the Examiner argues that even though Reid does not give any examples near the claimed acid to copper ranges, it allegedly achieves the same results using a different approach – by adding other ingredients (e.g., accelerators and levelers) to the compositions rather than as Applicants have, by changing the conventional wisdom regarding the acid to copper ratios (Office action dated 6/8/2006, last para. p. 3 - p. 4). The Examiner has the legal analysis backward. That Reid takes a different approach to solve the problem solved by Applicants' claimed compositions is evidence of non-obviousness, not obviousness. Otherwise no one could patent a novel, non-obvious solution to a problem if somebody else first proposed a different solution to the problem. That is not the law. The correct legal analysis is whether the claimed solution to the problem, Applicants' claimed acid and copper concentrations, is taught or suggested by the Reid acid and copper compositions.

*h. The Examiner Improperly Disregards the Extensive Comparison Test Data Disclosed in Applicants' Specification*

Second, the Examiner's analysis is factually wrong - the Examiner plainly disregards the comparative data. The Examiner asserts that the unexpected superior results disclosed in Applicants' specification are "inherent" properties in the prior art compositions because those properties were merely the discovery of previous unappreciated properties of the prior art compositions (Office action dated 6/8/2006, p. 3). But the comparative test data proves otherwise. As the acid and copper concentrations were the only variables in the comparison testing, it is clear that the prior art (including Reid) acid and copper concentrations did not possess those beneficial properties of the claimed compositions. On the contrary, the prior art



compositions resulted in voids in the depositions while the claimed compositions did not (Spec. pp. 22-26).

*i. The Examiner Ignores the Fact that the Prima Facie Case of Obviousness was Rebutted with Evidence that the Narrow Acid and Copper Concentrations Claimed are Critical to Achieve Unexpected Superior Results*

Lastly, the Examiner relies on the genus allegedly disclosed in Reid to reject Applicants' species claims. The broad ranges disclosed in Reid (acid 0-300g/L and copper 10-60 g/L) do not teach or suggest Applicants' narrowly claimed compositions. The Examiner ignores the well-settled law that a *prima facie* case of obviousness can be, and in this case has been, rebutted.

Specifically, where a cited reference discloses a genus that includes the claimed species, for example, if a reference broadly discloses composition constituent concentration ranges that encompass the claimed compositions constituent ranges, a *prima facie* case of obviousness arises. The burden is then shifted to the Applicant to show why the narrower claimed ranges are not obvious in view of the broad disclosure. *In re Peterson*, 315 F.3d 1325 (Fed. Cir. 2003); MPEP §§ 716.02(a) and 2144.05 (see Appendix XIII). Applicant can rebut the *prima facie* obviousness by showing that the claimed composition ranges are critical to achieve unexpected results relative to the prior art ranges. *In re Peterson*, 315 F.3d 1325 (Fed. Cir. 2003); MPEP § 2144.05(III).

*j. The Examiner Recognized that the Acid and Copper Concentrations are Critical to the Operability of Electrochemical Deposition Compositions and Applicants' Showed Unexpected Superior Results*

As discussed above, although broad ranges can support a *prima facie* case of obviousness, such a case can be rebutted with evidence of the criticality of narrower concentration ranges for achieving the unexpected superior results. Also as discussed above, the Examiner recognizes that the acid and copper concentrations are critical. Applicants' comparative data varying only the acid and copper concentrations resulting in superior depositions clearly rebutted the *prima facie* case of obviousness.

*k. The Examiner Cites Nothing in Reid that Would Guide One to Transform the Broad Ranges of Reid into Applicants' Superior, Narrowly Claimed Compositions with their Unconventional Low Acid-to-Copper Ratios*

Further, the prior art reference must provide sufficient guidance to a person of ordinary skill in the art to make the narrower claimed composition, in order to make those claimed compositions obvious. *Minnesota Mining and Manufacturing v. Johnson and Johnson Orthopedics, Inc.*, 976 F.2d 1559 (Fed. Cir. 1992). Here, the Examiner cites nothing in Reid that would guide one to transform the broad ranges of Reid into Applicants' superior, narrowly claimed compositions with their unconventional low acid-to-copper ratios. If the references' ranges are so broad as to be meaningless with respect to the claimed compositions and the references provide no guidance on providing the narrowly claimed invention with its beneficial features, then the references do not support an obviousness rejection. *Minnesota Mining and Manufacturing v. Johnson and Johnson Orthopedics, Inc.*, 976 F.2d 1559 (Fed. Cir. 1992).

The Reid genus does not teach or suggest Applicants' narrow composition ranges, as recited in claim 1. Claims 2-5 depend from claim 1 and are thus also not taught or suggested by the art of reference. Applicants' request that the rejections to the claims be reversed.

3. Rejection of claims 6-14 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857)

*Claims 6-14*

Claim 6 has the same acid and copper ranges as recited in claim 1 and further recites a range of suppressor. Claim 6 is allowable over the art of record for the same reasons as set forth above in relation to claim 1. Claims 7-14 depend from claim 6 and are allowable for the reasons set forth above in relation to claim 1 and are allowable over the art of record based on each of those claims unique and non-obvious combination of features. Applicants' request that the rejections to the claims be reversed.

4. Rejection of claims 15-18 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857)

*Claims 15-18*

Claim 15 has the same acid and copper ranges as recited in claim 1 and further recites a range of suppressor, accelerator and hydrogen chloride. Claim 15 is allowable over the art of record for the same reasons as set forth above in relation to claim 1. Claims 16-18 depend from claim 15 and are allowable for the reasons set forth above in relation to claim 1 and are allowable over the art of record based on each of those claims unique and non-obvious combination of features. Applicants' request that the rejections to the claims be reversed.

5. Rejection of claims 19-25 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857)

*Claims 19-25*

Claim 19 has a recitation of even narrower acid and copper ranges than as recited in claim 1 and further recites a suppressor and accelerator. Claim 19 is allowable over the art of record for the same reasons as set forth above in relation to claim 1. Claims 20-25 depend from claim 19 and are allowable for the reasons set forth above in relation to claim 1 and are allowable over the art of record based on each of those claims unique and non-obvious combination of features. Applicants' request that the rejections to the claim be reversed.

6. Rejection of claims 26-33 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857)

*Claims 26-33*

Claim 26 (and dependent claims 27-33) of the present application recites in part, a composition comprising an aqueous mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.4 to about 0.8. This carefully defined range of ratios is not taught or suggested by the cited Reid references.

a. *The Broad Copper to Acid Ratio Ranges Disclosed in Reid Do Not Teach or Suggest the Narrow Ratio Ranges Recited in Claims 26-33*

As discussed above, Reid only discloses the broad ranges of sulfuric acid of 0 - 300 g/L and copper of 10 - 60 g/L. Also as discussed above in relation to claim 1, the broad ranges presenting a *prima facie* case of obviousness were rebutted by the comparative test results in Applicants' specification. As is readily apparent, the same arguments apply to the composition and narrow ratio range recited in claim 26.

The only ratios taught or suggested in Reid are 17.5 g/L copper to 175 g/L of sulfuric acid and 170 g/L acid to 18 g/L copper ('796 patent, Table 2; '857 patent c. 3, l. 33-38 and Examples 1-3). These Reid copper to acid ratios - 0.10 and 0.11 - are far outside the claimed range of 0.4 to 0.8. Thus, no *prima facie* case of obviousness can be based on the taught ratios of Reid. In addition, the *prima facie* obviousness case based on the broad ratio ranges of Reid was clearly rebutted with the comparative test data disclosed in Applicants' specification, as discussed above. That is, any possible obviousness showing has been rebutted with evidence of unexpected superior results based on the critical acid and copper ratios. The Reid patent discloses the very prior art that Applicants differentiate both in their specification (see, e.g., p. 8, ll. 24-29 and all the comparison analysis data, in Appendix XII herein) and the present claims. Reid neither teaches nor suggests the presently claimed compositions and thus the rejection of claims 26-33 should be reversed.

7. Rejection of claim 34 under § 103(a) in view of Reid (US Patent No. 6,793,796)

*Claim 34*

Claim 34 recites in part, a composition comprising an aqueous mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.3 to about 0.8. Claim 34 is allowable for the same reasons as set forth immediately above in relation to claim 26 and as set forth above in relation to claim 1. Applicants' request that the rejection to the claim be reversed.

8. Rejection of claims 35-43 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857)

*Claims 35-43*

- a. *The Broad Reid Ranges Do Not Teach or Suggest the Claimed Acid and Copper Concentrations and the Reid Taught Acid and Copper Ranges are Well Below Applicants' Claimed 60%-90% Solubility Limit for the Copper Concentration*

Claim 35 recites, in part, an aqueous mixture of copper and sulfuric acid wherein the copper concentration in the composition is within about 60% to about 90% of its solubility limit when the sulfuric acid concentration is from about 65 to about 150 g/L.

Nothing in Reid teaches or suggests including copper in sulfuric acid at 60-90% of its solubility limit and the Examiner cites no teaching or suggestion of such in Reid. The one Reid cite showing an actual copper to acid ratio (e.g., col. 8, Table 2) teaches a composition wherein the copper concentration (i.e., 17.5 g/L in 175 g/L acid - Table 2) is well below 60% of its solubility limit. This can be verified by reviewing solubilities of copper in acid or by simply reviewing Fig. 1 of Applicants' specification where such solubility limits are graphed.

Accordingly, no *prima facie* case of obviousness has been presented for claims 35-43 and Applicants request that the rejections be reversed.

9. Rejection of claims 44-52 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857)

*Claims 44-52*

Claim 44 (and dependent claims 45-52) of the present application recites in part, a composition comprising about 40 g/L copper and about 100 g/L sulfuric acid. Claims 44-52 are allowable over the art of record for the same reasons as set forth above in relation to claim 1. Applicants request that the rejections be reversed.

10. Rejection of claims 53 and 54 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857)

*Claims 53-54*

Claim 53 (and dependent claim 54) of the present application recites in part, a composition comprising about 50 g/L copper and about 80 g/L sulfuric acid. Claims 53 and 54 are allowable over the art of record for the same reasons as set forth above in relation to claim 1. Applicants request that the rejections be reversed.

11. Rejection of claims 55-56, 58, 60 and 62 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Uzoh (US Patent App. No. 2002/0033342)

*Claims 55-56, 58, 60 and 62*

*a. Reid Does Not Teach or Suggest the Narrow Acid and Copper Ranges Claimed*

Claim 55 recites in part, a method for plating a workpiece utilizing an electroplating composition comprising about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. Again, for the same reasons as discussed above, Reid neither teaches nor suggests utilizing such a composition.

*b. The Examiner Rightly Recognizes that Uzoh Does not Make Up for the Reid Deficiencies Since Uzoh, Like Reid, Discloses Only Very Broad Ranges for Acid and Copper*

Uzoh does not make up for the deficiencies of the Reid patents as Uzoh neither teaches nor suggests utilizing compositions as recited in Applicants' claims. Of course, Applicants note that the Examiner is not asserting that Uzoh teaches or suggest the methods utilizing the compositions presently claimed since Uzoh only discloses a genus of acid and copper compositions. However, Uzoh, whether considered individually or in combination with Reid, neither teaches nor suggests the compositions utilized in the methods of present claim 55. Claims 56, 60 and 62 are dependent upon claim 55 and thus are allowable over the art of record as well as claim 55. Applicants respectfully request that the rejections of claims 55-56, 60 and 62 be reversed.

12. Rejection of claims 57, 59 and 61 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Uzoh (US Patent App. No. 2002/0033342) and further in view of Basol (US Patent No. 6,833,063)

*Claims 57, 59 and 61*

- a. *Basol Does Not Make Up for the Deficiencies of the Reid or Uzoh Patents Since Basol Teaches Methods for Etching and Basol Only Discloses Very Broad Ranges for Acid and Copper*

Claims 57, 59 and 61 recite methods using the same copper and acid compositions as discussed above in relation to claim 55 and as discussed above, neither Reid nor Uzoh teach such compositions.

Basol does not make up for the deficiencies of the Reid or Uzoh patents as Basol neither teaches nor suggests utilizing compositions as narrowly recited in Applicants' claims. Applicants recognize that the Examiner does not suggest that Basol teaches the methods utilizing the compositions presently claimed.

Because these claims are allowable over the Reid and Uzoh patents for the same reasons as discussed immediately above in relation to claim 55 and as set forth above in relation to claim 1, and because Basol does not make up for the deficiencies of Reid and Uzoh, Applicants respectfully request that the rejections be reversed.

13. Rejection of claims 63-65 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Reid (US Patent No. 6,024,857)

*Claims 63-65*

Claim 63 recites in part, a method for plating a workpiece utilizing an electroplating composition comprising about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. Again, for the same reasons as discussed above in relation to claim 1, Reid neither teaches nor suggests utilizing such a composition. Applicants request that the rejections be reversed.

14. Rejection of claims 66-67 are obvious under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Wilson (US Patent App. No. 2005/0178667)

*Claims 66-67*

Claim 66 recites in part, a process for applying a metallization interconnect structure utilizing an electroplating composition comprising about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. Again, for the same reasons as discussed above in relation to claim 1, Reid neither teaches nor suggests utilizing such a composition.

Wilson does not make up for the deficiencies of the Reid patent as Wilson neither teaches nor suggests utilizing compositions as recited in Applicants' claim 66. In fact, Wilson does not even disclose an acid or copper electrochemical deposition composition so there is no way it could make up for the deficiencies of the Reid patents. Applicants recognize that the Examiner is not asserting that Wilson teaches the methods utilizing the compositions presently claimed. However, because Wilson does not make up for the deficiencies in the Reid references, Wilson, whether considered individually or in combination with the Reid patents, neither teaches nor suggests the compositions utilized in the method of present claim 66 or dependent claim 67. Thus, Applicants respectfully request that the rejections be reversed.

15. Rejection of claims 68-69 under § 103(a) in view of Reid (US Patent No. 6,793,796) in combination with Wilson (US Patent App. No. 2005/0178667)

*Claims 68-69*

- a. Reid's Disclosed Broad Copper to Acid Ratios (the Genus) Does Not Teach or Suggest the Narrowly Claimed Copper to Acid Ratios (the Species)*

Claim 68 recites in part, a method utilizing a composition comprising a mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.4 to about 0.8. This carefully defined copper to acid ratio range is not taught or suggested by the cited Reid references.



*b. Applicants' Comparative Test Results Rebutted Any Prima Facie Obviousness Case Presented by Reid's Broad Ratios and Reid's Only Taught Ratios are Far Outside Applicant's Claimed Copper to Acid Ratios*

As discussed above, Reid only discloses the broad ranges of sulfuric acid of 0 - 300 g/L and copper of 10 - 60 g/L. Also as discussed above in relation to claim 1, the comparative tests in Applicants' specification rebutted any *prima facie* case of obviousness the broad ranges may support. As is readily apparent, the same arguments apply to the composition recited in claim 68.

The only ratios taught in Reid are 17.5 g/L copper to 175 g/L of sulfuric acid and 170 g/L acid to 18 g/L copper ('796 patent, Table 2; '857 patent c. 3, l. 33-38 and Examples 1-3). The prior art copper to acid ratios - 0.10 and 0.11 - are far outside the claimed range of 0.4 to 0.8. Thus, no *prima facie* case of obviousness can be based on the taught ratios of Reid. In addition, the Examiner's the *prima facie* obviousness case based on the broad ratio ranges was clearly rebutted with the Applicants' evidence of unexpected, superior results. The Reid patent discloses the very prior art that Applicants differentiate both in their specification (see, e.g., p. 8, ll. 24-29 and all the comparison analysis data) and the present claims. As discussed above in Item 14, Wilson does not even disclose a acid and copper electrodeposition composition so there is no way it could make up for the deficiencies of the Reid patents. The cited art neither teaches nor suggests the presently claimed methods and thus the rejection of claims 68-69 should be reversed.

16. Rejection of claims 1-5 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756)

*Claims 1-5*

*a. Grandikota Only Discloses Acid Ranges Outside Applicants' Claimed Range and the Specific Acid and the Copper Composition in Grandikota Cited by the Examiner is Far Below the Claimed Acid Range*

Nothing in Grandikota teaches or suggests the claimed composition of about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. Grandikota teaches that a relatively high copper concentration of 30-55 g/L copper as compared to its required low acid

concentration 4-60 g/L (claim 1 as cited by the Examiner; and [0018-0019]). In other words, in Grandikota the copper concentration is relatively high as compared to the acid concentration. Further, Grandikota discloses an acid range below the acid range recited in the present claims. This reference neither teaches nor suggests the acid range claimed in any of the presently considered claims of the current application. Indeed, the Grandikota reference substantiates all the comments made above regarding the prior art teaching either a relatively high copper to a low acid concentration or a low copper to a relatively high acid concentration but never teaches or suggests the relative recited ranges as currently claimed. Further, the other portion of this reference cited by the examiner (i.e., [0016] especially lines 7-8) recites an acid concentration of only 4-10 g/L -- far below the presently claimed 65-150 g/L sulfuric acid.

In addition, Grandikota stresses that lower acid concentrations and relatively higher copper concentrations need to be used for uniform depositions. In paragraph [0018] at lines 4-7, Grandikota states that "an electroplating solution having high copper concentration, i.e., greater than 0.4 M, is beneficial to overcome mass transport limitations that are encountered when plating small features." Grandikota then states (at [0018] lines 12-16) that a high copper concentration enhances diffusion and reduces mass transport limitations. Following statements about high copper concentrations, Grandikota states, "A lower acid concentration permits the use of a higher metal ion [concentration] . . ." (at [0018], lines 19-22). Grandikota further states (at [0019], lines 1-4 and 16-17), "a high sulfuric acid concentration may be detrimental to uniform plating because the resistive substrate effects may be amplified by a highly conductive plating solution. . . . Therefore, the electroplating solution includes an acid at a concentration of between about 4 gm/L and about 60 gm/L."

Clearly Grandikota teaches use of a low acid concentration, i.e., between 4 and 60 g/L - which range is below Applicants' claimed range of about 65 to about 150 g/L. Further, Grandikota teaches that lower acid not higher acid concentrations are necessary for uniform plating. This further argues against any finding that Grandikota makes the higher acid concentration as claimed obvious. That is, Grandikota's disclosed low acid concentration range does not overlap with Applicants' high acid concentration range claimed and Grandikota asserts that higher acid concentrations are to be avoided.

The other cited references do not make up for the deficiencies of Grandikota, nor does the Examiner assert that they do. Clearly the Grandikota reference neither teaches nor suggests the

presently claimed compositions or methods recited in claims 1-5. Applicants request that the rejections be reversed.

17. Rejection of claims 6-14 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756)

*Claims 6-14*

Claim 6 has the same acid and copper ranges as recited in claim 1 and further recites a range of suppressor. Claim 6 is allowable over the art of record for the same reasons as set forth in relation to claim 1 (in Item 16 above). Claims 7-14 depend from claim 6 and are allowable for the reasons set forth in relation to claim 1 (in Item 16 above). Applicants' request that the rejections to the claims be reversed.

18. Rejection of claims 15-18 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756)

*Claims 15-18*

Claim 15 has the same acid and copper ranges as recited in claim 1 and further recites a range of suppressor, accelerator and hydrogen chloride. Claim 15 is allowable over the art of record for the same reasons as set forth in relation to claim 1 (in Item 16 above). Claims 16-18 depend from claim 15 and are allowable for the reasons set forth above in relation to claim 1 and are allowable over the art of record based on each of those claims unique and non-obvious combination of features. Applicants' request that the rejections to the claims be reversed.

19. Rejection of claims 19-25 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756)

*Claims 19-25*

Claim 19 has an even narrower recitation of acid and copper ranges than as recited in claim 1 and further recites a suppressor and accelerator. Claim 19 is allowable over the art of record for the same reasons as set forth in relation to claim 1 (in Item 16 above). Claims 20-25 depend from claim 19 and are allowable for the reasons set forth above in relation to claim 1 and are allowable over the art of record based on each of those claims unique and non-obvious combination of features. Applicants' request that the rejections to the claim be reversed.

20. Rejection of claims 26-33 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756)

*Claims 26-33*

- a. Grandikota Does Not Teach or Suggest the Claimed Copper to Acid Range but Instead Teaches to Have a Low Acid Concentration*

Claim 26 (and dependent claims 27-33) of the present application recites in part, a composition comprising an aqueous mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.4 to about 0.8. This carefully defined range of ratios is not taught or suggested by the cited references.

As discussed above, Grandikota teaches a copper concentration that is relatively high, which then requires a low acid concentration 4-60 g/L (claim 1 as cited by the Examiner; and [0018-0019]) and Grandikota teaches that 4-10 g/L as disclosed in the Grandikota embodiment mentioned by the Examiner (Grandikota, [0016]) is useful. This type of disclosure of relatively low acid concentration compositions when copper concentrations are relatively high, is one of the very types of prior art the present applicants distinguished through comparative test data. Accordingly, Applicants request the rejections be reversed.

21. Rejection of claim 34 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964)

*Claim 34*

Claim 34 recites in part, a composition comprising an aqueous mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.3 to about 0.8. Claim 34 is allowable for the same reasons as set forth immediately above in relation to claim 26 (Item 20 above) and as set forth in relation to claim 1 (Item 16 above). Applicants' request that the rejection to the claim be reversed.

22. Rejection of claims 35-43 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756)

*Claims 35-43*

Claim 35 recites, in part, an aqueous mixture of copper and sulfuric acid wherein the copper concentration in the composition is within about 60% to about 90% of its solubility limit when the sulfuric acid concentration is from about 65 to about 150 g/L.

- a. *The Grandikota Acid Concentration Cited by the Examiner is Outside Applicants' Claimed Acid Range and the Examiner Cites No Disclosure in Grandikota Where Grandikota Suggests the Claimed Acid Range or the Claimed Copper Solubility Range*

Nothing in Grandikota or Gabe teach or suggest including copper in sulfuric acid at 60-90% of its solubility limit when the sulfuric acid concentration is from about 65 to about 150 g/L and the Examiner cites no specific teaching or suggestion in the references. In fact, the Examiner cites the sections of Grandikota wherein the acid range is outside applicants recited range – specifically, Grandikota discloses and the Examiner relies on an acid range of 4-60 g/L acid and the claimed composition recites 65 to 150 g/L (Grandikota [0019] and claim 1) (Office action dated March 8, 2006, p. 32).

Accordingly, no *prima facie* case of obviousness has been presented for claims 35-43 and Applicants request that the rejections be reversed.

23. Rejection of claims 44-52 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756)

*Claims 44-52*

Claim 44 (and dependent claims 45-52) of the present application recites in part, a composition comprising about 40 g/L copper and about 100 g/L sulfuric acid. Claims 44-52 are allowable over the art cited herein for the same reasons as set forth in relation to claim 1 (Item 16 above). Applicants request that the rejections be reversed.

24. Rejection of claims 53 and 54 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Gabe (US Patent App. No. 2003/0066756)

*Claims 53 and 54*

Claim 53 (and dependent claim 54) recites in part, a composition comprising about 50 g/L copper and about 80 g/L sulfuric acid. Claims 53 and 54 are allowable over the cited art herein for the same reasons as set forth in relation to claim 1 (Item 16 above). Applicants request that the rejections be reversed.

25. Rejection of claims 55-62 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Uzoh (US Patent App. No. 2002/0033342) and further in view of Basol (US Patent No. 6,833,063)

*Claims 55-62*

Claim 55 recites in part, a method for plating a workpiece utilizing an electroplating composition comprising about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. Again, for the same reasons as discussed in relation to claim 1 (Item 16 above), the cited reference Grandikota – and the secondary references – fail to teach nor suggest utilizing such a composition. Applicants request the rejections be reversed.

26. Rejection of claims 66 and 67 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Reid (US Patent No. 6,793,796) in combination with Wilson (US Patent App. No. 2005/0178667)

*Claims 66-67*

Claim 66 recites in part, a process for applying a metallization interconnect structure utilizing an electroplating composition comprising about 35 to about 60 g/L copper and about 65 to about 150 g/L sulfuric acid. Again, for the same reasons as discussed above in relation to claim 1, Grandikota neither teaches nor suggests utilizing such a composition.

Wilson does not make up for the deficiencies of the Grandikota patent as Wilson neither teaches nor suggests utilizing compositions as recited in Applicants' claim 66. In fact, as discussed above in Item 14, Wilson does not even disclose an electroplating deposition composition. Applicants recognize that the Examiner is not asserting that Wilson teaches the methods utilizing the compositions presently claimed. However, Wilson, whether considered

individually or in combination with the Grandikota patent, neither teaches nor suggests the compositions utilized in the method of present claim 66 or dependent claim 67. Thus, Applicants respectfully request that the rejections be reversed.

27. Rejection of claims 68 and 69 under § 103(a) in view of Grandikota (US Patent App. No. 2002/0112964) in combination with Reid (US Patent No. 6,793,796) in combination with Wilson (US Patent App. No. 2005/0178667)

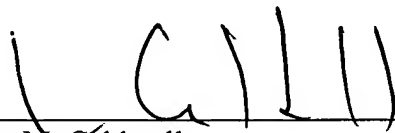
*Claims 68-69*

Claim 68 recites in part, a method utilizing a composition comprising a mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.4 to about 0.8. For the same reasons as discussed in relation to claim 26 (Item 20 above), the cited reference Grandikota – and the secondary references Reid for the reasons set forth above in relation to claim 26 (at Item 6 above) – fail to teach nor suggest utilizing such a composition. Applicants request the rejections be reversed.

Respectfully submitted,

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### **VIII. Appendix**

1. An aqueous-based electroplating composition comprising:  
about 35 to about 60 g/L copper;  
about 65 to about 150 g/L sulfuric acid; and  
a glycol-based suppressor.
2. The composition of claim 1 wherein the glycol-based suppressor is present at a concentration of from about 2 to about 30 ml/L.
3. The composition of claim 1 further comprising a copper-deposition accelerator present at a concentration of from about 2 to about 30 ml/L.
4. The composition of claim 1 further comprising from about 10 to about 100 ppm halide ion.
5. The composition of claim 1 further comprising from about 30 to about 60 ppm HCl.
6. An electroplating composition comprising:  
about 35 to about 60 g/L copper;  
about 65 to about 150 g/L sulfuric acid; and  
about 2 to about 30 ml/L of a copper-deposition suppressor;  
wherein the balance of the composition is water.
7. The composition of claim 6 further comprising a copper-deposition accelerator at a concentration of from about 2 to about 30 ml/L.
8. The composition of claim 6 wherein the copper-deposition suppressor is a random or block copolymer.
9. The composition of claim 6 wherein the copper-deposition suppressor is a copper bath viaform suppressor.



10. The composition of claim 6 wherein the copper-deposition suppressor is glycol-based.
11. The composition of claim 6 further comprising a copper-deposition accelerator.
12. The composition of claim 11 wherein the copper-deposition accelerator is a copper bath viaform accelerator.
13. The composition of claim 11 wherein the copper-deposition accelerator is SPS.
14. The composition of claim 6 further comprising from about 10 to about 100 ppm HCl.
15. An aqueous electroplating composition comprising:  
about 35 to about 60 g/L copper;  
about 65 to about 150 g/L sulfuric acid;  
about 2 to about 30 ml/L copper-deposition accelerator;  
about 2 to about 30 ml/L copper-deposition suppressor; and  
about 40 to about 60 ppm hydrogen chloride.
16. The composition of claim 15 wherein the copper-deposition suppressor is glycol-based.
17. The composition of claim 15 wherein the copper-deposition accelerator is a sulphur containing compound.
18. The composition of claim 1 further comprising about 50 ppm HCl.
19. An electroplating composition comprising:  
about 45 to about 55 g/L copper;  
about 75 to about 120 g/L sulfuric acid;

a copper-deposition suppressor; and  
a copper-deposition accelerator.

20. The composition of claim 19 wherein the copper-deposition suppressor is at a concentration of from about 2 to about 10 ml/L.

21. The composition of claim 19 wherein the copper-deposition accelerator is present at a concentration of from about 2 to about 8 ml/L.

22. The composition of claim 19 further comprising from about 10 to about 100 ppm halide ion.

23. The composition of claim 19 further comprising from about 30 to about 60 ppm HCl.

24. The composition of claim 21 wherein the copper-deposition accelerator is a sulphur containing compound.

25. The composition of claim 19 further comprising a leveler.

26. An electroplating composition comprising:  
an aqueous mixture of copper and sulfuric acid wherein the ratio in g/L of solution of copper to acid is equal to about 0.4 to about 0.8;  
a copper-deposition suppressor; and  
a copper-deposition accelerator.

27. The composition of claim 26 wherein the copper-deposition suppressor is a random or block copolymer.

28. The composition of claim 26 wherein the copper-deposition suppressor is a copper bath viaform suppressor.

29. The composition of claim 26 wherein the copper-deposition suppressor is glycol-based.

30. The composition of claim 26 wherein the copper-deposition accelerator is present in a concentration of from about 2 to about 30 ml/L.

31. The composition of claim 26 wherein the copper-deposition accelerator is a copper bath viaform accelerator.

32. The composition of claim 26 wherein the copper-deposition accelerator is SPS.

33. The composition of claim 26 further comprising from about 10 to about 100 ppm HCl.

34. An electroplating composition comprising:  
an aqueous-based mixture of copper and sulfuric acid wherein the ratio in g/L solution of copper to acid is equal to about 0.3 to about 0.8;  
a copper-deposition suppressor;  
a copper-deposition accelerator;  
wherein only electroplating compositions comprising the aqueous-based mixture of copper and sulfuric acid wherein the ratio in g/L of copper to acid is equal to about 0.3 to about 0.8 are used to deposit copper on a workpiece.

35. An electroplating composition comprising:  
an aqueous mixture of copper and sulfuric acid wherein the copper concentration in the composition is within about 60% to about 90% of its solubility limit when the sulfuric acid concentration is from about 65 to about 150 g/L;  
a copper-deposition suppressor; and  
a copper-deposition accelerator.

36. The composition of claim 35 wherein the copper-deposition suppressor is present at a concentration of from about 2 to about 30 ml/L.

37. The composition of claim 35 wherein the copper-deposition accelerator is present at a concentration of from about 2 to about 30 ml/L.

38. The composition of claim 36 further comprising from about 10 to about 100 ppm halide ion.

39. The composition of claim 36 further comprising from about 30 to about 60 ppm HCl.

40. The composition of claim 36 wherein the copper-deposition suppressor is at a concentration of from about 2 to about 10 ml/L.

41. The composition of claim 36 wherein the copper-deposition accelerator is present at a concentration of from about 2 to about 8 ml/L.

42. The composition of claim 36 wherein the copper-deposition accelerator is a sulphur containing compound.

43. The composition of claim 36 wherein the copper-deposition suppressor is glycol-based.

44. An electroplating composition comprising:  
about 40 g/L copper;  
about 100 g/L sulfuric acid;  
a copper-deposition suppressor; and  
a copper-deposition accelerator.

45. The composition of claim 44 wherein the copper-deposition suppressor is present at a concentration of from about 2 to about 30 ml/L.

46. The composition of claim 44 wherein the copper-deposition accelerator is present at a concentration of from about 2 to about 30 ml/L.

47. The composition of claim 44 further comprising from about 10 to about 100 ppm halide ion.

48. The composition of claim 44 further comprising from about 30 to about 60 ppm HCl.

49. The composition of claim 44 wherein the copper-deposition suppressor is at a concentration of from about 2 to about 10 ml/L.

50. The composition of claim 44 wherein the copper-deposition accelerator is present at a concentration of from about 2 to about 8 ml/L.

51. The composition of claim 44 wherein the copper-deposition accelerator is a sulphur containing compound.

52. The composition of claim 44 wherein the copper-deposition suppressor is glycol-based.

53. An aqueous electroplating composition comprising:  
about 50 g/L copper;  
about 80 g/L sulfuric acid;  
about 2 to about 10 ml/L copper-deposition suppressor; and  
about 2 to about 8 ml/L copper-deposition accelerator.

54. The composition of claim 53 further comprising from about 10 to about 100 ppm halide ion.

55. A method for plating a workpiece comprising:  
providing a workpiece having a plurality of device features including a seed layer  
wherein the plurality of device features is to be metallized;

electrolytically depositing copper within the plurality of device features utilizing an electroplating composition comprising about 35 to about 60 g/L copper, about 65 to about 150 g/L sulfuric acid, and a glycol-based suppressor.

56. The method of claim 55 further comprising a seed enhancement procedure.

57. The method of claim 55 further comprising rinsing and drying the workpiece, wherein the rinsing and/or the drying occurs in a chamber in which the deposition of copper is performed.

58. The method of claim 55 further comprising selective etching of copper deposited on the workpiece.

59. The method of claim 55 further comprising cleaning the backside of the workpiece after copper is deposited on the workpiece.

60. The method of claim 55 further comprising annealing the workpiece at temperatures below about 100°C.

61. The method of claim 55 further comprising precleaning the workpiece prior to depositing copper wherein the precleaning of the workpiece is performed in a plating tool in which plating tool the deposition is also performed.

62. The method of claim 55 wherein the electroplating composition comprises from about 35 to about 60 g/L copper, from about 65 to about 150 g/L sulfuric acid, and from about 2 to about 30 ml/L of glycol-based copper-deposition suppressor.

63. A method for plating a workpiece comprising:  
providing a workpiece having a plurality of device features including a seed layer wherein the plurality of device features is to be metallized;

electrolytically depositing copper within the plurality of device features utilizing an electroplating composition comprising from about 35 to about 60 g/L copper, from about 65 to about 150 g/L sulfuric acid, from about 2 to about 30 ml/L copper-deposition accelerator, from about 2 to about 30 ml/L copper-deposition suppressor; and from about 40 to about 60 ppm hydrogen chloride.

64. The method of claim 63 wherein the electroplating composition comprises a mixture of copper and sulfuric acid wherein the ratio in g/L of copper to acid is equal to about 0.4 to about 0.8.

65. The method of claim 63 wherein the electroplating composition comprises a mixture of copper and sulfuric acid wherein the ratio in g/L of copper to acid is equal to about 0.3 to about 0.8, and wherein only electroplating compositions comprising a mixture of copper and sulfuric acid wherein the ratio in g/L of copper to acid is equal to about 0.3 to about 0.8 are used to deposit copper on the workpiece.

66. A process for applying a metallization interconnect structure, comprising:  
providing a workpiece on which a metal seed layer has been formed using a first deposition process;

enhancing the seed layer by electrochemically depositing additional metal on the seed layer within a principal fluid chamber of a reactor to provide an enhanced seed layer using a deposition process comprising supplying electroplating power to a plurality of concentric anodes disposed at different positions within the principal fluid flow chamber relative to the workpiece;  
and

electrolytically depositing a metal on the enhanced seed layer utilizing an electroplating composition comprising about 35 to about 60 g/L copper, about 65 to about 150 g/L sulfuric acid, and a glycol-based suppressor.

67. The process of claim 66 wherein the electroplating composition comprises from about 35 to about 60 g/L copper, from about 65 to about 150 g/L sulfuric acid, and from about 2 to about 30 ml/L of the glycol-based suppressor.

68. A process for applying a metallization interconnect structure, comprising:  
providing a workpiece on which a metal seed layer has been formed;  
enhancing the seed layer by electrochemically depositing additional metal on the seed layer within a principal fluid chamber of a reactor to provide an enhanced seed layer using a deposition process comprising supplying electroplating power to a plurality of electrodes within the principal fluid flow chamber,  
independently controlling the supply of electrical power to the at least two electrodes during enhancing of the seed layer; and  
electrolytically depositing copper on the enhanced seed layer under conditions in which the deposition rate of the electrolytic deposition process is substantially greater than the deposition rate of the process used to enhance the metal seed utilizing an electroplating composition comprising a mixture of copper and sulfuric acid wherein the ratio in g/L of copper to acid is equal to about 0.4 to about 0.8, a copper-deposition suppressor, and a copper-deposition accelerator.

69. The method of claim 68 wherein the ratio in g/L of copper to acid is equal to about 0.3 to about 0.8.



**IX. Evidence Appendix**

No evidence to add.

**XI. Related Proceedings Appendix**

No related proceedings.

## **XII. Comparative Test Results as Disclosed in the Specification**

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**Example 1 and Comparative Data**

A representative embodiment of the electroplating composition of this invention is shown in Table 1.

**Table 1**

5	<u>Component</u>	<u>Concentration g/L</u>
	Cu	50
	H <sub>2</sub> SO <sub>4</sub>	80
	Accelerator (DF74)	5.0
	Suppressor (DF75)	2.0
10	Leveler (DF79)	2.5
	HCL	50*

\* Halogen concentration in ppm.

With suitable current densities (such as those set forth above), void free filling  
15 was achieved with this embodiment of the electrochemical composition, as illustrated in the results shown in Figs. 2(e), 3(d), 4(d)-4(f) and 5(b).

For comparison purposes, prior art electroplating compositions were tested under the same conditions with identical additives at the identical concentrations. Features having voids, as can be seen in Figs. 4(a) – 4(c) were obtained. Specifically,  
20 prior art electroplating compositions comprising the conventional high copper and low acid combination (i.e., 50 g/L Cu and 10 g/L sulfuric acid) produced vias having visible voids. A comparison of the results shown in Figs. 4(a)-(c) versus 4(d)-(f) reveal that the prior art high copper/low acid electroplating compositions (Figs. 4(a)-(c)) result in the formation of interconnects having significant voids, seen as dark spots in the  
25 micrographs at the lower regions of the interconnects. Although the filling of the interconnects using one embodiment of the electroplating compositions of this invention as shown in Fig. 4(d) was halted prior to completely filling the interconnect trench, as can be seen in the micrograph of 4(d), the interconnects were forming without visible

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voids – a significant improvement over the conventional electroplating composition results. Additionally, although the interconnects formed using an embodiment of the electroplating compositions as shown in Fig. 4(f) show some voiding, the number and size of the voids in the interconnects are significantly fewer and smaller as compared to the resulting voiding in interconnects formed using the prior art high copper/low acid electroplating composition, as can be seen in the microphotograph of Fig. 4(c).

For further comparison, another prior art electroplating composition (i.e., a conventional low copper/high acid composition) was tested under the same conditions with identical additives (at identical concentrations) resulting in trenches having seam voids as is illustrated in Fig. 5(a). Specifically, a prior art electroplating composition comprising 20 g/L Cu and 180 g/L sulfuric acid produced seam voids in metallized trenches. In comparison, an embodiment of the electrochemical plating compositions of this invention, specifically a composition comprising 80 g/L sulfuric acid and 50 g/L Cu, produced void free features in the identical size trenches (as shown in Fig. 5(b)).

#### **Example 2 and Comparative Data**

Another embodiment of the electroplating composition of this invention is shown in Table 2.

**Table 2**

<u>Component</u>	<u>Concentration g/L</u>
Cu	40
H <sub>2</sub> SO <sub>4</sub>	100
Accelerator (B-3100)	10.0
Suppressor (C-3100)	17.5
Leveler (U-3100)	3.0

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HCL

20\*

\* Halogen concentration in ppm.

5 With suitable current densities, such as those set forth above, void free filling of a via was achieved with this embodiment of the electroplating composition of this invention as is illustrated in Fig. 6(b).

For comparison purposes, a prior art electroplating composition was tested under the same conditions with identical additives (at identical concentrations) as was Example 2. A via fill having voids, as can be seen in Fig. 6(a), was obtained with the prior art composition. Specifically, the prior art electroplating composition compared had the conventional high acid and low copper combination (i.e., 20 g/L Cu and 180 g/L sulfuric acid) producing a via having visible voids, as shown in Fig. 6(a) while the embodiments of the electroplating compositions of this invention showed surprisingly superior results, a void-free via filling was achieved, as shown in Fig. 6(b).

15

**Example 3**

As shown in Figs. 2(a) through 2(e), copper semiconductor interconnect trenches measuring about 0.12 to about 0.15  $\mu\text{m}$  in width at half the height of the interconnect were filled using various embodiments of the electroplating compositions wherein the copper concentration was varied while the acid concentration was about 80 g/L and were compared to various prior art compositions. Specifically, as shown in Figs. 2(a) and 2(c), interconnect trenches were filled utilizing a prior art electroplating composition comprising 20 g/L copper and 80 g/L acid. As can be seen in the micrographs of these figures, the prior art low copper/high acid compositions result in devices having visible voids. In comparison, however, as shown in Figs. 2(b) and (d), the electroplating compositions of this invention having copper and acid concentrations near the copper solubility limit resulted in devices having a relatively low number of voids formed. Specifically, as shown in Figs. 2(b) and 2(d), interconnect trenches were

20

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filled utilizing an electroplating composition comprising 35 g/L copper and 80 g/L acid providing superior results.

#### **Example 4**

5           As the Fig. 2(f) tabulated results show a number of example electroplating compositions tested wherein the copper concentration was increased step-wise and the acid concentrations were kept relatively low. This increase in copper concentration relative to the low acid concentration (contrary to conventional wisdom) again gave surprisingly superior results.

10           Specifically, the additive concentrations and halide concentrations were held constant while the acid and copper concentrations were varied from 10g/l to 150g/l and from 20g/l to 50g/l, respectively. After plating, the plated wafers were cross-sectioned and examined for the presence of voids. For each example of electroplating compositions tested, five filled features at each of three sizes (0.12, 0.15, 0.20  $\mu\text{ms}$ )  
15           were examined. The number of features filled out of five was tallied for each size. A perfect score would be 5 at each size. This data was then entered into a statistical analysis software tool (i.e., a JMP statistical analysis software program) that generated the pictured leverage plot shown in Fig. 2(f). As can be seen from Fig. 2(f), electroplating compositions wherein the copper concentration was relatively high and  
20           the acid concentration was relatively low (i.e., embodiments of the electroplating compositions of this invention wherein copper concentrations were near solubility limits) provide a statistically significant improvement in feature bottom-up fill capabilities

#### **Example 5 and Comparative Data**

25           As shown in Figs. 3(a)-3(d), copper semiconductor interconnect trenches measuring about 0.15  $\mu\text{m}$  in width at half the height of the interconnect were filled using electroplating compositions wherein the sulfuric acid concentration was varied

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while the copper concentration was 20 g/L or 50 g/L (20 g/L Cu and 80 and 150 g/L acid, respectively in Figs. 3(a)-(b)) and 50 g/L Cu with 10 and 80 g/L acid, respectively in Figs. 3(c)-(d)). As shown in Fig. 3(a), an interconnect trench was filled utilizing an electroplating composition comprising 20 g/L copper and 80 g/L acid.

5 For comparison purposes, as shown in Fig. 3(b), an interconnect trench was filled utilizing an electroplating composition comprising 20 g/L copper and 150 g/L sulfuric acid – like the typical conventional high acid/low copper compositions. Again, inferior results are achieved with such a composition.

For further comparison purposes, as shown in Fig. 3(c), an interconnect trench  
10 was filled utilizing an electrochemical composition comprising 50 g/L copper and 10 g/L sulfuric acid. Results are shown in Fig. 3(c). (The results shown in Fig. 3(d) show the superior results achieved with the electroplating composition of this invention as described above in Example 1.)

#### 15 **Example 6**

As the Fig. 3(f) tabulated results further demonstrate, increasing the acid concentration while increasing the copper concentration so that it is at or near its solubility limit provides a statistically significant improvement in feature fill. A number of example electroplating compositions were tested wherein the acid  
20 concentration was increased step-wise and the copper concentrations were kept relatively high – near its solubility limits for the particular acid concentrations.

Specifically, the additive concentrations and halide concentrations were held constant while the acid and copper concentrations were varied from 10g/l to 150g/l and from 20g/l to 50g/l, respectively. After plating, the plated wafers were cross-sectioned  
25 and examined for the presence of voids. For each example of electroplating composition tested, five filled features at each of three sizes (0.12, 0.15, 0.20  $\mu\text{ms}$ ) were examined. The number of features filled out of five was tallied for each size. A perfect score would be 5 at each size. This data was then entered into a statistical analysis

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software tool (i.e., a JMP statistical analysis software program) that generated the pictured leverage plot shown in Fig. 3(f). As can be seen from Fig. 3(f), electroplating compositions wherein the copper concentration was at or near its solubility limit provide statistically significant improvement in feature bottom-up fill capabilities.

5           Whereas the electroplating compositions and methods of this invention have been described with reference to multiple embodiments and examples, it will be understood that the invention is not limited to those embodiments and examples. On the contrary, the invention is intended to encompass all modifications, alternatives, and equivalents as may be included within the spirit and scope of the invention as defined  
10 by the appended claims.





Fig. 2(a)



Fig. 2(b)



Fig. 2(c)



Fig. 2(d)



Fig. 2(e)

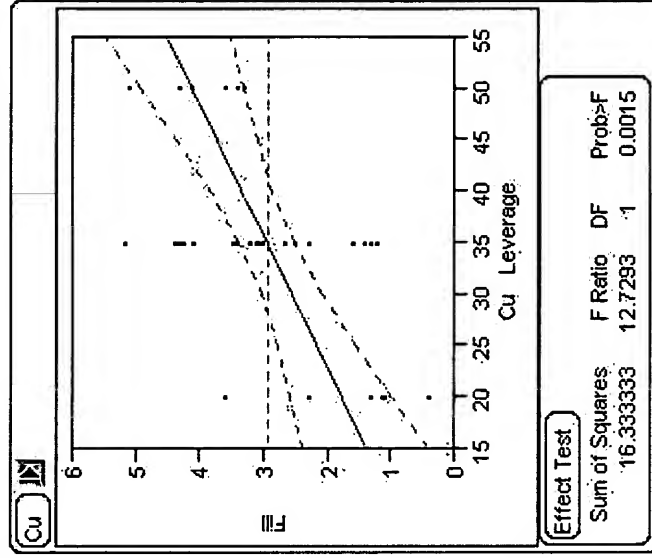


Fig. 2(f)



Fig. 3(a)



Fig. 3(b)



Fig. 3(c)



Fig. 3(d)

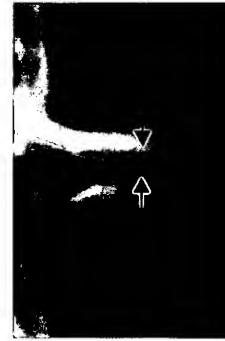


Fig. 3(e)

Fig. 3(f)

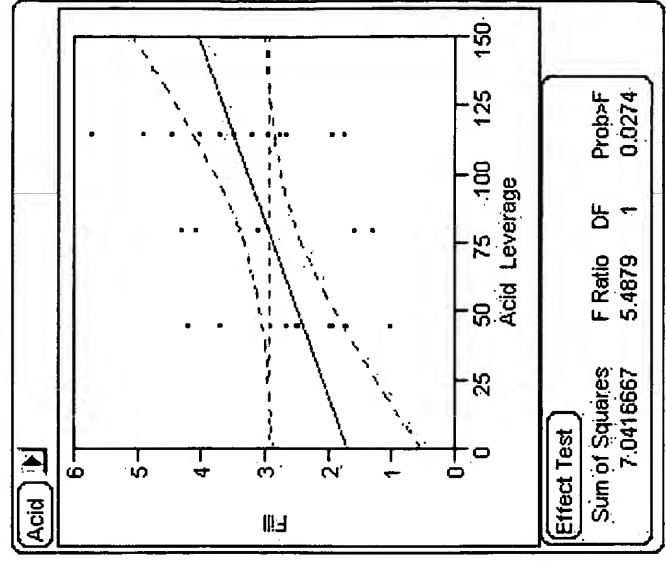




Fig. 4(a)

PRIOR ART



Fig. 4(b)

PRIOR ART

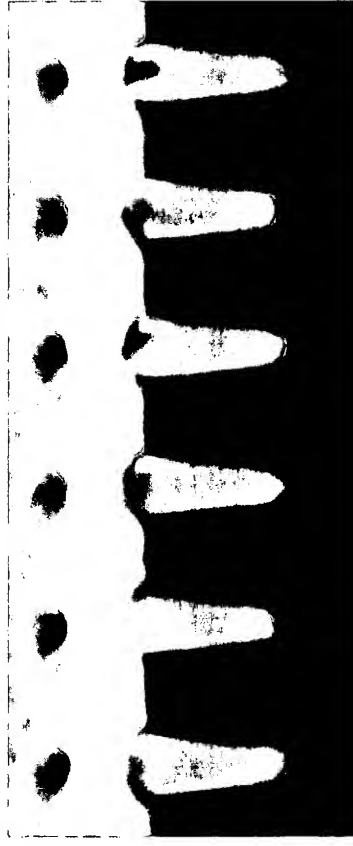


Fig. 4(c)

PRIOR ART



Fig. 4(d)



Fig. 4(e)

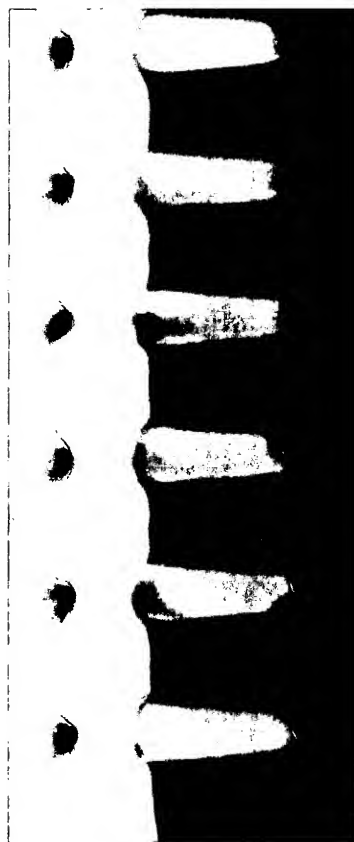


Fig. 4(f)

Fig. 5(a)

PRIOR ART

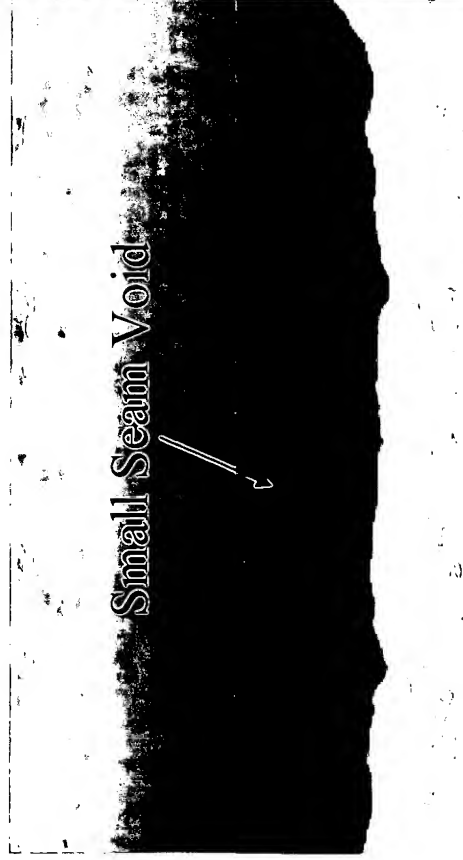


Fig. 5(b)

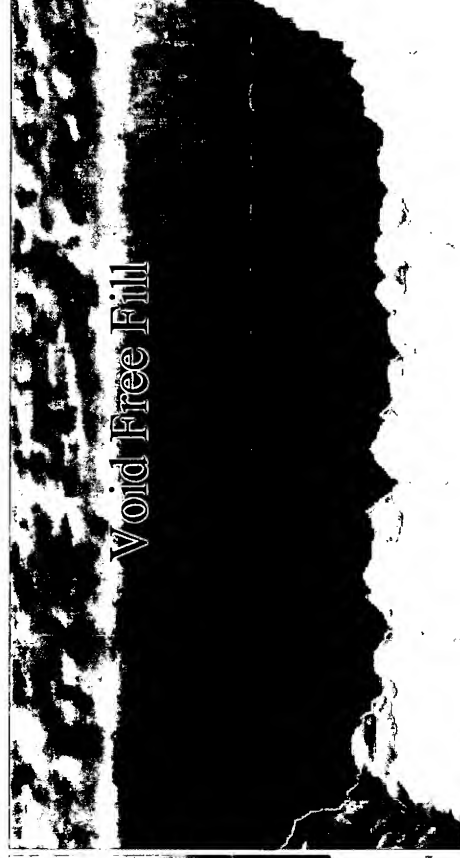


Fig. 6(a)

PRIOR ART

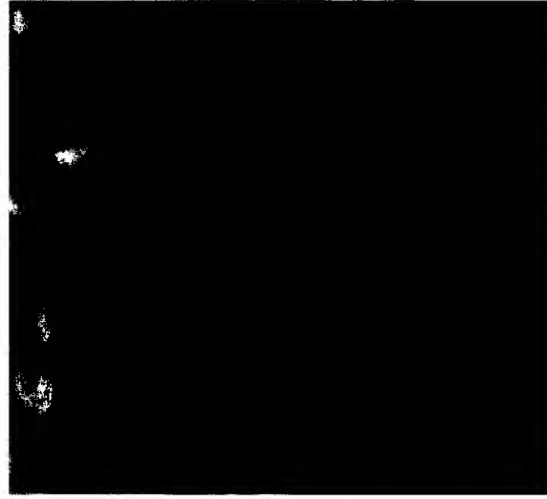
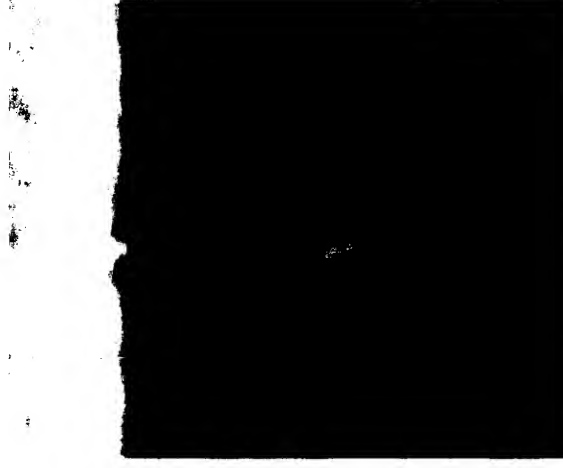


Fig. 6(b)



**XIII. Case Law and MPEP References Cited by Applicants**



In re Lance G. PETERSON and Ioannis Vasatis.

No. 02-1129.

United States Court of Appeals,  
Federal Circuit.

Jan. 8, 2003.

Patent applicant appealed from decision of United States Patent and Trademark Office Board of Patent Appeals and Interferences claiming that composition was obvious, which included relatively small amount of rhenium to improve single-crystal alloy's mechanical strength without reducing its hot-corrosion resistance. The Court of Appeals, Lourie, Circuit Judge, held that: (1) inventor's claimed element ranges were encompassed by ranges disclosed in prior art reference; (2) inventor did not show unexpected results commensurate in scope with claimed range of rhenium; and (3) prior art did not teach away from claimed composition.

Affirmed.

Patents  $\S$  1613

In the patent context, the ultimate determination whether an invention would have been obvious is a legal conclusion based on underlying findings of fact. 35 U.S.C.A.  $\S$  103.

Patents  $\S$  113(6)

Court of Appeals reviews de novo the legal conclusion of obviousness by the Patent and Trademark Office Board of Patent Appeals and Interferences and its underlying factual determinations for substantial evidence. 35 U.S.C.A.  $\S$  103.

Patents  $\S$  314(5)

In the patent context, whether an invention has produced unexpected results and whether a reference teaches away from a claimed invention are questions of

4. Patents  $\S$  113(6)

Under the substantial evidence standard, the Court of Appeals affirms the factual determinations by the Patent and Trademark Office Board of Patent Appeals and Interferences if they are based upon such relevant evidence as a reasonable mind might accept as adequate to support a conclusion.

5. Patents  $\S$  36(1)

In the patent context, a prima facie case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art. 35 U.S.C.A.  $\S$  103.

6. Patents  $\S$  36(3)

Substantial evidence supported findings by Patent and Trademark Office (PTO) Board of Patent Appeals that inventor's claimed element ranges were encompassed by ranges disclosed in prior art reference, rendering inventor's claimed composition prima facie obvious; inventor asserted that it was not prima facie obvious to select claimed narrower ranges from broader ranges in prior art reference; however, even slight overlap in range established prima facie case of obviousness. 35 U.S.C.A.  $\S$  103.

7. Patents  $\S$  36(1)

In the patent context, a prior art reference that discloses a range encompassing a somewhat narrower claimed range is sufficient to establish a prima facie case of obviousness. 35 U.S.C.A.  $\S$  103.

8. Patents  $\S$  32

In the patent context, the existence of overlapping or encompassing ranges shifts the burden to the patent applicant to show that his invention would not have been obvious. 35 U.S.C.A.  $\S$  103.

9. Patents  $\S$  16(2)

In the patent context, the selection of a narrow range from within a somewhat broader range disclosed in a prior art reference is no less obvious than identifying a range that simply overlaps a disclosed range; in fact, when the claimed ranges are completely encompassed by the prior art, the conclusion is even more compelling than in cases of mere overlap. 35 U.S.C.A.  $\S$  103.

10. Patents  $\S$  36(3)

Substantial evidence supported findings by Patent and Trademark Office (PTO) Board of Patent Appeals, that inventor did not show unexpected results commensurate in scope with claimed range of rhenium, in inventor's attempt to rebut prima facie case of obviousness over composition that included relatively small amount of rhenium to improve single-crystal alloy's mechanical strength without reducing its hot corrosion resistance; even though data showed that alloy strength improved with addition of rhenium, they did not evidence unexpected results for entire claimed range. 35 U.S.C.A.  $\S$  103.

11. Patents  $\S$  36(1)

In general, a patent applicant may overcome a prima facie case of obviousness by establishing that a claimed range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range; that same standard applies when the applicant seeks to optimize certain variables by selecting narrow ranges from broader ranges disclosed in the prior art and, furthermore, the applicant's showing of unexpected results must be commensurate in scope with the claimed range. 35 U.S.C.A.  $\S$  103.

12. Patents  $\S$  36(1)

A patent applicant may rebut a prima facie case of obviousness by showing that the prior art teaches away from the

claimed invention in any material respect. 35 U.S.C.A.  $\S$  103.

13. Patents  $\S$  36(3)

Substantial evidence supported findings by Patent and Trademark Office (PTO) Board of Patent Appeals, that prior art did not teach away from claimed composition that included relatively small amount of rhenium improve single-crystal alloy's mechanical strength without reducing its hot corrosion resistance, in inventor's attempt to rebut prima facie case of obviousness; even though prior art reference mentioned preferred alloy that did not contain rhenium, it did not discourage use of alloys containing rhenium. 35 U.S.C.A.  $\S$  103.

James T. Hosmer, Nixon & Vandeventer P.C., of Arlington, VA, argued for appellants. With him on the brief was Leonard C. Mitchard.

William LaMarca, Associate Solicitor, Office of the Director of the United States Patent and Trademark Office, of Arlington, VA, argued for the Director. With him on the brief were John M. Whelan, Solicitor, and Joseph Piccolo, Associate Solicitor.

Before LOURIE, BRYSON, and DYK, Circuit Judges.

LOURIE, Circuit Judge.

Lance G. Peterson and Ioannis Vassiliou (collectively, "Peterson") appeal from the decision of the U.S. Patent and Trademark Office ("PTO") Board of Patent Appeals and Interferences affirming the rejection of claims 1-7 of U.S. Patent Application 08/365,392 as obvious under 35 U.S.C.  $\S$  103. *Ex Parte Wood*, Appeal No. 1995-0535, Paper No. 19 (B.P.A.I. Apr. 1995).

2001). Because substantial evidence supports the Board's factual findings and the Board did not err in its conclusion of obviousness, we affirm.

# BACKGROUND

On December 28, 1994, Mr. Peterson filed U.S. Patent Application 08/365,392, which is directed to a nickel-base single-crystal superalloy used in the manufacture of industrial gas turbine engines exposed to high temperatures. The claimed composition includes a relatively small amount of rhenium and aims to improve a single-crystal alloy's mechanical strength without reducing its hot corrosion resistance. Representative claim 5 recites:

A nickel-base superalloy having special utility in the production of single crystal gas turbine engine blades consisting essentially of about 1 to 3 percent rhenium, about 14 percent chromium, about 95 percent cobalt, about 3.8 percent tungsten, about 2 percent tantalum, about 1.5 percent molybdenum, about 0.05 percent carbon, about 0.004 percent boron and, respectively, from about 3 to 4.8 percent aluminum, from about 4.8 percent to about 3 percent titanium, and balance substantially nickel.

(Emphases added.) Peterson and the Board considered that the other claims and/or fall with claim 5, and we will therefore consider only claim 5.

The examiner rejected claims 1-7 under 35 U.S.C. § 103 as obvious over the following prior art references: (1) published European Patent Application 240,451 (Shah); (2) published European Patent Application 076,360 ("Wukusick"); alone or in view of U.K. Patent 2,153,848 ("Dühl"); and (3) U.S. Patent 3,619,182 ("Bieber") in view of Wukusick. For each ground of rejection, the examiner found a *prima facie* case of obviousness based on the overlapping element ranges of the prior art compositions and the claimed composition.

Peterson responded by arguing that his invention would not have been obvious because the prior art disclosed only the optional use of rhenium and did not suggest that controlled amounts of rhenium would result in advantageous mechanical properties. Peterson also pointed to the unexpected results achieved by his invention, namely, the increased stress rupture life resulting from the addition of a small amount of rhenium. The examiner rejected those arguments in a final office action, finding that Peterson had failed to show criticality of the selected amount of rhenium commensurate in scope with the claims.

The Board affirmed the examiner's rejection. First, the Board found that the disclosure of overlapping ranges in Shah, Wukusick, and Bieber each established a *prima facie* case of obviousness. With respect to the rejection based primarily on Wukusick, the Board determined that the claimed range of "about 14 percent chromium" encompassed Wukusick's teaching to use up to 12% chromium. Secondly, the Board found that Peterson had failed to show that the claimed alloy possesses properties that would have been considered unexpected by a person of ordinary skill in the art. Specifically, the Board found that Peterson had not compared the claimed invention with the closest prior art (Wukusick's Alloy 2) and had not shown that the claimed range of rhenium was critical to improving stress rupture life. Thus, the Board concluded that Peterson's evidence of nonobviousness did not outweigh the evidence of obviousness and affirmed the examiner's rejection of claims 1-7. Peterson timely appealed. We have jurisdiction pursuant to 28 U.S.C. § 1295(a)(4)(A).



## DISCUSSION

[1-4] The ultimate determination whether an invention would have been obvious under 35 U.S.C. § 103 is a legal conclusion based on underlying findings of fact. *In re Kotzab*, 217 F.3d 1365, 1369, 55 USPQ2d 1313, 1316 (Fed. Cir. 2000). We review the Board's legal conclusion of obviousness *de novo* and its underlying factual determinations for substantial evidence. *In re Gartside*, 203 F.3d 1305, 1316, 53 USPQ2d 1769, 1776 (Fed. Cir. 2000). Whether an invention has produced unexpected results and whether a reference teaches away from a claimed invention are questions of fact. *In re Mayne*, 104 F.3d 1339, 1343, 41 USPQ2d 1451, 1455 (Fed. Cir. 1997) (unexpected results); *Para-Ordinance Mfg. v. SGS Importers Int'l*, 73 F.3d 1085, 1088, 37 USPQ2d 1237, 1239 (Fed. Cir. 1995) (teaching away). Under the substantial evidence standard, we affirm the Board's factual determinations if they are based upon "such relevant evidence as a reasonable mind might accept as adequate to support a conclusion." *In re Gartside*, 203 F.3d at 1312, 53 USPQ2d at 1773 (quoting *Consolidated Edison Co. v. NLRB*, 305 U.S. 197, 217, 59 S.Ct. 206, 83 L.Ed. 126 (1938)).

On appeal, Peterson argues that the cited prior art does not establish a *prima facie* case of obviousness because it does not suggest the claimed combination of about 1 to 3 percent rhenium with about 14 percent chromium to create an alloy having improved strength. As to the first ground of rejection, Peterson contends that a skilled artisan would not have assumed from Shah that using the claimed amounts of rhenium and chromium would improve alloy strength because Shah defines very broad ranges for rhenium (0-7%) and chromium (3-18%), mentions rhenium only as an optional ingredient, and discloses a preferred alloy containing no rhenium. With respect to the second

ground of rejection, Peterson asserts that the Board misconstrued the phrase "about 14 percent chromium" to include 12% chromium. Peterson also argues that Wukusick only discloses the optional use of rhenium and does not suggest the combination of rhenium and chromium in the amounts claimed. As to the final ground of rejection, Peterson argues that Bieber does not mention rhenium as a component in its alloys and even warns that increasing the chromium content to improve corrosion resistance will have "catastrophic effect on other properties."

Peterson alternatively argues that, even if a *prima facie* case of obviousness was established, the Board erred in determining that the evidence of nonobviousness was insufficient to rebut the *prima facie* case. Peterson points out that the claimed invention was the first to achieve the combination of corrosion resistance and improved strength for a nickel-base single crystal superalloys. Peterson thus contends that the examiner and the Board failed to appreciate the criticality of the unexpected results achieved by the claimed combination of about 1-3% rhenium with, among other elements, about 14% chromium. Peterson further argues that Wukusick and Bieber teach away from the claimed invention by warning that the chromium contents can adversely affect alloy strength.

The PTO responds that the Board correctly found that the claimed composition would have been obvious based on any one of the three grounds of rejection because Shah, Wukusick, and Bieber all disclose ranges of elements that overlap all claimed ranges. The PTO argues that the Board properly interpreted the phrase "about 14 percent chromium" to include Wukusick's 12% chromium because Example I in Peterson's application disclosed a superalloy containing 12.03% chromium.

The PTO further responds that the Board correctly determined that Peterson failed to overcome the *prima facie* case of obviousness. The PTO contends that substantial evidence supports the Board's findings that Wukusick does not teach away from the invention and that Peterson failed to show unexpected results. Specifically, the PTO points out that Peterson's specification shows improved performance in stress rupture life, only for 2% rhenium, rather than for the full claimed range of about 1-3% rhenium, and that Peterson failed to compare his results with the closest prior art.

#### A. The Prima Facie Case of Obviousness

[5, 6] A *prima facie* case of obviousness typically exists when the ranges of a claimed composition overlap the ranges disclosed in the prior art. *E.g.*, *In re Geisler*, 116 F.3d 1465, 1469, 43 USPQ2d 1362, 1365 (Fed. Cir. 1997); *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936-37 (CCPA 1990); *In re Malagari*, 499 F.2d 1297, 1303, 182 USPQ 549, 553 (CCPA 1974). Such is the case here. Claim 5 of Peterson's application recites and Shah discloses superalloys having the following compositions:

Claim 5	Shah
Rhenium about 1-3%	about 0-7%
Chromium about 14%	3-18%
Cobalt about 9.5%	0-20%
Tungsten about 3.8%	0-18%
Tantalum about 2%	0-15%
Molybdenum about 1.5%	0-4%
Carbon about 0.05%	at least 0.002%
Boron about 0.004%	at least 0.002%
Aluminum about 3-4.8%	1-8%
Titanium about 4.8% to balance	balance
Nickel about 3% to balance	balance

Clearly, Peterson's application and Shah contain overlapping ranges, as each range listed in Peterson's claim 5 lies within the corresponding range disclosed in Shah. Thus, Shah's ranges encompass Peterson's. Peterson argues that, despite that overlap, it would not have been *prima facie* obvious to select the claimed narrower

ranges of rhenium and chromium from Shah's broader ranges of those elements. We disagree. In cases involving overlapping ranges, we and our predecessor court have consistently held that even a slight overlap in range establishes a *prima facie* case of obviousness. *E.g.*, *In re Woodruff*, 919 F.2d at 1578, 16 USPQ2d at 1936-37 (concluding that a claimed invention was rendered obvious by a prior art reference whose disclosed range ("about 1-5% carbon monoxide") abutted the claimed range ("more than 5% to about 25% carbon monoxide")); *In re Malagari*, 499 F.2d at 1303, 182 USPQ at 553 (concluding that a claimed invention was rendered *prima facie* obvious by a prior art reference whose disclosed range (0.020-0.035% carbon) overlapped the claimed range (0.030-0.070% carbon)); *see also* *In re Geisler*, 116 F.3d at 1469, 43 USPQ2d at 1365 (acknowledging that a claimed invention was rendered *prima facie* obvious by a prior art reference whose disclosed range (50-100 Angstroms) overlapped the claimed range (100-600 Angstroms)). We have also held that a *prima facie* case of obviousness exists when the claimed range and the prior art range do not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 783, 227 USPQ 773, 779 (Fed. Cir. 1985) (concluding that a claim directed to an alloy containing "0.8% nickel, 0.3% molybdenum, up to 0.1% maximum iron, balance titanium" would have been *prima facie* obvious in view of a reference disclosing alloys containing 0.75% nickel, 0.25% molybdenum, balance titanium and 0.94% nickel, 0.31% molybdenum, balance titanium). [7-9] In light of that case law, we conclude that a *prima facie* case of obviousness was made out in this case. Selecting a narrow range from within a somewhat

broader range disclosed in a prior art reference is no less obvious than identifying a range that simply *overlaps* a disclosed range. In fact, when, as here, the claimed ranges are completely encompassed by the prior art, the conclusion is even more compelling than in cases of mere overlap. The normal desire of scientists or artisans to improve upon what is already generally known provides the motivation to determine where in a disclosed set of percentage ranges is the optimum combination of percentages. See *In re Boesch*, 617 F.2d 272, 276, 205 USPQ 215, 219 (CCPA 1980) ("[D]iscovery of an optimum value of a result effective variable in a known process is ordinarily within the skill of the art." (citations omitted)).<sup>1</sup> We therefore conclude that a prior art reference that discloses a range encompassing a somewhat narrower claimed range is sufficient to establish a *prima facie* case of obviousness. That is not to say that the claimed composition having a narrower range is unpatentable. Rather, the existence of overlapping or encompassing ranges shifts the burden to the applicant to show that his invention would not have been obvious, as we discuss below. Accordingly, because Shah's ranges encompass Peterson's, we conclude that the Board did not err in determining that Shah renders Peterson's claimed composition *prima facie* obvious.<sup>2</sup>

1. Although ranges that are not especially broad invite routine experimentation to discover optimum values, rather than require nonobvious invention, we do not have here any assertion that the disclosed range is so broad as to encompass a very large number of possible distinct compositions. We thus do not need to decide whether a disclosed range of such breadth might present a situation analogous to our cases involving the failure of a very broad disclosed genus of substances to render *prima facie* obvious specific substances within its scope. See, e.g., *In re Baird*, 16 F.3d 380, 29 USPQ2d 1550 (Fed.Cir.1994); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed.Cir.1992).

#### B. *Rebuttal of the Prima Facie Case*

[10, 11] We turn next to Peterson's attempt to rebut the *prima facie* case of obviousness. In general, an applicant may overcome a *prima facie* case of obviousness by establishing "that the [claimed] range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range." *In re Geisler*, 116 F.3d at 1469-70, 43 USPQ2d at 1365 (alteration in original) (quoting *In re Woodruff*, 919 F.2d at 1578, 16 USPQ2d at 1936). That same standard applies when, as here, the applicant seeks to optimize certain variables by selecting narrow ranges from broader ranges disclosed in the prior art. See *In re Geisler*, 116 F.3d at 1470, 43 USPQ2d at 1365 ("Only if the 'results of optimizing a variable' are 'unexpectedly good' can a patent be obtained for the claimed critical range." (quoting *In re Antonie*, 559 F.2d 618, 620, 195 USPQ 6, 8 (CCPA 1977))); *In re Wertheim*, 541 F.2d 257, 267, 191 USPQ 90, 100 (CCPA 1976) (recognizing that "ranges which overlap or lie inside ranges disclosed by the prior art may be patentable if the applicant can show criticality in the claimed range by evidence of unexpected results"). Moreover, the applicant's showing of unexpected results must be commensurate in scope with the claimed range. See *In re Greenfield*, 571 F.2d

2. Consequently, we need not address the *prima facie* obviousness arguments based on the Wukusick, Duhl, and Bieber references. We note, however, that those references are less convincing than Shah in creating a *prima facie* case of obviousness. There is no genuine overlap between Wukusick's disclosed range of 7-12% chromium and Peterson's claimed range of "about 14 percent chromium." Peterson's only mention of an alloy having about 12% chromium is of a test alloy in its comparative Example I; it is not an example of Peterson's invention. Duhl and Bieber do not even mention rhenium, let alone disclose compositions with rhenium.



1185, 1189, 1197 USPQ 227, 230 (CCPA 1978) ("Establishing that one (or a small number of) species gives unexpected results is inadequate proof, for it is the view of this court that objective evidence of non-obviousness must be commensurate in scope with the claims which the evidence is offered to support." (quoting *In re Tiffin*, 58 C.C.P.A. 1420, 448 F.2d 791, 792, 171 USPQ 294, 294 (CCPA 1971))).

We agree with the PTO that substantial evidence supports the Board's finding that Peterson failed to show that the addition of rhenium results in unexpected improvements in alloy strength for the entire claimed range of "about 1 to 3 percent" rhenium. The specification includes several examples of superalloy compositions and their respective strengths, measured by average rupture life. Of most relevance are the following data disclosed in those examples: Example I, which contains no rhenium, resulted in an average rupture life of about 34 hours; Example II, which includes 1% rhenium, resulted in an average rupture life of about 57 hours; Example III, which contains 2% rhenium, resulted in an average rupture life of about 114 hours. Although those data show that alloy strength improved with the addition of rhenium, they do not evidence unexpected results for the entire claimed range of about 1-3% rhenium. From the few data points provided, the most significant improvement in stress rupture life occurred with the addition of 2% rhenium. However, the Board's implicit conclusion that the addition of rhenium in the lower portion of the claimed range did not produce unexpected results (i.e., the addition of 1% rhenium increased stress rupture life from 34 hours to only 57 hours) is supported by substantial evidence, and there are no data to show that the addition of rhenium in the uppermost portion of the claimed range (i.e., 3% rhenium) would lead to unexpected

results. In fact, the only data that report the stress rupture life of an alloy having 3% rhenium seem to suggest the opposite. In an experiment similar to that demonstrated by Examples I-III, Example IV includes no rhenium and resulted in an average rupture life of about 148 hours. Example V, which contains 2% rhenium, resulted in an average rupture life of about 275 hours. Example VI, which contains 3% rhenium but less titanium than Examples IV and V, resulted in an average rupture life of only about 130 hours. Thus, the only data for an alloy containing 3% rhenium actually show a decrease in average rupture life as compared with alloys having 0% or 2% rhenium. Moreover, whether an applicant has shown unexpected results is a question of fact, on which we defer to the Board. We therefore conclude that substantial evidence supports the Board's finding that Peterson has not shown unexpected results that are commensurate in scope with the claimed range of "about 1-3 percent" rhenium. [12, 13] Alternatively, an applicant may rebut a *prima facie* case of obviousness by showing that the prior art teaches away from the claimed invention in any material respect. *In re Geisler*, 116 F.3d at 1469, 43 USPQ2d at 1365 (quoting *In re Malagard*, 499 F.2d at 1303, 182 USPQ at 553). Peterson contends that the prior art teaches away from the claimed invention in that Wukusick teaches that the amount of chromium must be reduced when rhenium is added to a nickel-base superalloy for strength purposes. Peterson also argues that Bieber teaches away from the invention by warning that a high chromium content can have "catastrophic effects" on alloy strength. We agree with the PTO that substantial evidence supports the Board's finding that the prior art does not teach away from the claimed invention. Although the Board

did not expressly address "teaching away" in the context of Peterson's attempt to rebut the *prima facie* case of obviousness, it did find that the Shah, Wukusick, and Bieber references teach the invention and themselves establish *prima facie* cases of obviousness. Implicitly, then, the Board found that those references do not teach away from Peterson's invention. Certainly the Shah reference, the rejection on which we have affirmed the Board's decision, does not teach away from the invention. While it mentions a preferred alloy that does not contain rhenium, it does not disparage or otherwise discourage the use of alloys containing rhenium. Although Wukusick and Bieber may suggest upper limits on chromium content in order to avoid adverse effects on alloy strength, they disclose alloys containing as much as 12% and 14% chromium, respectively. Moreover, Wukusick expressly teaches that adding rhenium will improve high-temperature strength. Thus, substantial evidence supports the Board's factual finding that the prior art does not teach away from Peterson's combination of about 1-3% rhenium with about 14% chromium. We thus conclude that the Board did not err in its determination that Peterson failed to rebut the *prima facie* case of obviousness or in its ultimate conclusion that Peterson's claimed superalloy would have been obvious under § 103.

**CONCLUSION.** The Board's findings that Peterson's claimed element ranges are encompassed by the ranges disclosed in the Shah reference, that Peterson did not show unexpected results commensurate in scope with the claimed range of rhenium, and that the prior art does not teach away from the claimed invention. Thus, the Board did not err in concluding that claims 1-7 would

have been obvious under § 103. Accordingly, the Board's decision is **AFFIRMED.**

**KEY NUMBER SYSTEM**  
 1. Customs Duties  $\S$  85(3)  
 2. Federal Courts  $\S$  776  
 3. Constitutional interpretation is question of law, reviewed de novo, in Fed. Cir.

**ARBON STEEL & SERVICE CO., INC., Plaintiff-Appellant,**

**UNITED STATES, Defendant-Appellee.**

**No. 02-1299.**  
 United States Court of Appeals,  
 Federal Circuit.

**Jan. 10, 2003.**

Following its recovery of fees paid under export provision of the Harbor Maintenance Tax, exporter sought prejudgment interest. The United States Court of International Trade, 178 F.Supp.2d 1354, Jane A. Restani, J., denied interest, and exporter appealed. The Court of Appeals, Mayer, Chief Judge, held that: (1) statute authorizing award of interest against government on overpayment of internal revenue tax did not apply; and (2) denial of interest did not violate due process.

**Affirmed.**

**1. Customs Duties  $\S$  85(3).** The Court of Appeals reviews statutory interpretation by Court of International Trade without deference.

**2. Federal Courts  $\S$  776.** A Constitutional interpretation is question of law, reviewed de novo, in Fed. Cir.



## Court of Appeals, Federal Circuit

Minnesota Mining and Manufacturing Co.  
v. Johnson & Johnson Orthopaedics Inc.

No. 91-1428

Decided September 30, 1992

## PATENTS

1. Patentability/Validity — Anticipation —  
Identity of elements (§115.0704)JUDICIAL PRACTICE AND  
PROCEDUREProcedure — Judicial review — Standard  
of review — Patents (§410.4607.09)

Party asserting anticipation of patent claim under 35 USC 102 must demonstrate identity of invention, which in turn requires showing that each element of claim is found, either expressly or under principles of inherency, in single prior art reference, or that claimed invention was previously known or embodied in single prior art device or practice; federal district court's finding on issue of identity of invention is question of fact, subject to review under clearly erroneous standard.

## PATENTS

## 2. Patent construction — Claims — In general (§125.1301)

JUDICIAL PRACTICE AND  
PROCEDUREProcedure — Judicial review — Standard  
of review — Patents (§410.4607.09)

Claim construction is question of law, but if meaning of key terms is disputed and extrinsic evidence is necessary to explain them, then underlying factual questions may arise, resolution of which is reviewed on appeal for clear error.

## PATENTS

3. Patentability/Validity — Specification  
— Claim adequacy (§115.1109)Patent construction — Claims — Broad or  
narrow (§125.1303)Patent construction — Claims — Defining  
terms (§125.1305)

Special master did not read extraneous limitation into claims for curable resin-coated sheet used for casting broken bones by interpreting them to require some degree of

slipperiness, since claims require presence of lubricant in resin, and since master properly construed term "lubricant" and phrase "pre-lubricated curable resin-coated sheet" to require slippery surface on sheet, particularly in view of specification's emphasis on obtaining slippery feel or surface; such interpretation does not render claims indefinite, since amount of lubrication required is set forth in specification and should be sufficient to achieve purpose of invention, which is ability to rub and smooth casting material without resin and tape sticking to applicator's hands or gloves.

4. Patent construction — Claims — Broad  
or narrow (§125.1303)Patent construction — Claims — Defining  
terms (§125.1305)

Special master's findings of fact, discussing tests for calculating kinetic coefficient of friction (KCOF) of surface on pre-lubricated curable resin-coated sheet used in casting broken bones, did not constitute claim interpretation improperly requiring KCOF specified in claims to be calculated using standard substrate for resin.

5. Patentability/Validity — Anticipation —  
Prior art (§115.0703)

Prior art products cited by accused infringer as anticipating patent claims for pre-lubricated curable resin-coated sheet used in casting broken bones were properly rejected by special master, since chemicals which defendant cites as lubricants in prior art are either used in wrong form or in amounts too small to function as lubricants as required by claims.

6. Infringement — Defenses — Fraud or  
unclean hands (§120.1111)JUDICIAL PRACTICE AND  
PROCEDUREProcedure — Judicial review — Standard  
of review — Patents (§410.4607.09)

Proving inequitable conduct does not "invalidate" patent but rather renders it unenforceable; ruling on issue of inequitable conduct is discretionary.

## PATENTS

7. Infringement — Literal infringement  
(§120.05)

Special master's finding that accused pre-lubricated curable resin-coated sheet used in casting broken bones meets coefficient of friction limitation of plaintiff's patent claim

is affirmed, since parties presented conflicting test results in support of their respective positions, and since master did not clearly err by finding that plaintiff's tests of commercially available batches of accused product, conducted in accordance with procedures outlined in patent in suit, were more reliable than defendant's tests of factory experimental casting tape.

**8. Patentability/Validity — Anticipation — Identity of elements (§115.0704)**

Special master did not err by finding that claim for orthopedic casting material was not anticipated by prior patent, since reference states generally that fiberglass can be used as substrate in casting material; but does not provide information sufficiently exact to identify ranges of mesh size and thickness specified in claim at issue.

**9. Patentability/Validity — Obviousness — In general (§115.0901)**

**JUDICIAL PRACTICE AND PROCEDURE**

**Procedure — Judicial review — Standard of review — Patents (§410.4607.09)**

Determination of whether invention would have been obvious is reviewed de novo on appeal, although underlying factual inquiries, such as scope and content of prior art and differences between prior art and claimed invention, are reviewed under clearly erroneous standard; objective evidence, such as commercial success, failure of others, long-felt need, and unexpected results must also be considered before conclusion on obviousness is reached.

**PATENTS**

**10. Patentability/Validity — Obviousness — Person of ordinary skill in art (§115.0902)**

Person of ordinary skill in art of orthopedic casting at time of invention in question would have knowledge of chemistry equivalent to bachelor's degree; additional knowledge of resin systems and their curing mechanisms, experience in designing orthopedic casting materials and, particularly backings for such materials, and knowledge of clinical usage of casting materials.

**11. Patentability/Validity — Obviousness — Relevant prior art — Particular inventions (§115.0903.03)**

**Patentability/Validity — Obviousness — Secondary considerations generally (§115.0907)**

Secondary considerations support finding that plaintiff's orthopedic casting material

was not obvious at time of its invention, since record shows that, of major manufacturers in casting field, only plaintiff succeeded in developing casting system using fiberglass as substrate and solving foaming problem, that product embodying invention experienced tremendous commercial success, that such commercial success was due to technical merits of product, and that invention was licensed to one of plaintiff's competitors and copied by others.

**12. Infringement — Construction of claims (§120.03)**

**Patent construction — Claims — Defining terms (§125.1305)**

Special master properly construed "mesh size" specified in claim for orthopedic casting material to mean size of spaces or openings bounded by vertical and horizontal elements or threads in fabric substrate of material, since use of term "mesh" in claim implies coarseness or fineness of grid or screen-like structure, since "mesh number" and "mesh number openings" per square inch for various fabrics referred to in patent correspond with number calculated by multiplying number of vertical threads by number of horizontal threads per inch in fabrics; and since prosecution history of patent, prior art, and testimony of those skilled in art support such interpretation.

**JUDICIAL PRACTICE AND PROCEDURE**

**13. Procedure — Judicial review — Standard of review — In general (§410.4607.01)**

**REMEDIES**

**Monetary — Damages — In general (§510.0501)**

Size of damage award fixed by federal district court is question of fact reviewed under clearly erroneous standard, but certain subsidiary decisions underlying particular damage theory are discretionary with district court and are therefore reviewed for abuse of that discretion.

**14. Monetary — Damages — Patents — Lost profits (§510.0507.05)**

Special master did not err by determining that acceptable non-infringing substitutes for patented casting tapes were unavailable at time of infringement, since record supports master's finding that third party competitor was unable to manufacture commercially acceptable casting tapes, though it

invention, since manufacturers in the field proceeded in developing fiberglass as a problem, that an experienced person could have arrived at such a technical invention was not a consideration of competitors and the prior art.

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may have been entitled to manufacture tapes under license, and since defendant had opportunity to proffer convincing rebuttal evidence of non-infringing substitutes but failed to do so.

## JUDICIAL PRACTICE AND PROCEDURE

### 15. Procedure — Judicial review — Appealability (§410.4603)

## REMEDIES

### Monetary — Damages — Patents — Lost profits (§510.0507.05)

Patent infringement defendant cannot assert on appeal that its product constitutes acceptable, noninfringing substitute for patented casting tape, and that plaintiff therefore failed to carry its burden of showing absence of noninfringing substitutes, since such issue was not considered at trial.

### 16. Monetary — Damages — Patents — Lost profits (§510.0507.05)

Special master did not err by awarding plaintiff lost profits for price erosion based on determination that plaintiff would have been able to increase its prices two percent per annum during period of infringement if defendant had not been competing in market, since master's findings show that parties engaged in vigorous price competition for equivalent products which caused steady decline in price of casting tape which is subject of suit, and that parties' competitors had little effect on downward trend of prices; special master was not restricted to choosing figure advocated by either party, and thus properly substituted, as matter of judgment from available evidence, increment rate intermediate between zero percent urged by defendant and four percent asserted by plaintiff.

### 17. Monetary — Damages — Computation of damages (§510.0505)

### Monetary — Damages — Patents — Lost profits (§510.0507.05)

Special master did not err by setting \$10 million as amount of increased production costs for plaintiff's lost sales, even though defendant estimated those costs at over \$13 million and plaintiff estimated them to be slightly over \$7 million, since master was not restricted to choosing figure advocated by either party, and therefore did not err by selecting figure midway between parties' estimates.

## PATENTS

### 18. Infringement — Willful (§120.16)

## JUDICIAL PRACTICE AND PROCEDURE

### Procedure — Judicial review — Standard of review — Patents (§410.4607.09)

Issue of whether infringement is willful is one of fact and is thus reviewed for clear error on appeal; finding that defendant willfully infringed plaintiff's patents is not clearly erroneous, since special master applied correct legal standard and considered all relevant circumstances, and since master's findings were reviewed and considered, in light of defendant's arguments, by federal district court which adopted master's conclusion.

## PATENTS

### 19. Infringement — Willful (§120.16)

## REMEDIES

### Monetary — Damages — Patents — Increased damages (§510.0507.07)

Special master did not err by concluding that defendant had no reasonable basis for relying on in-house counsel's opinion that plaintiff's patent is invalid and unenforceable, since opinion was issued orally, since opinion was not objective, inasmuch as information underlying opinion was obtained from defendant's supplier rather than from independent expert, and since circumstances show that defendant knew patented process was not in prior art as claimed, and had no reasonable basis to believe counsel's contention that plaintiff submitted fraudulent affidavits to Patent and Trademark Office.

## PATENTS

### 20. Infringement — Willful (§120.16)

## REMEDIES

### Monetary — Damages — Patents — Increased damages (§510.0507.07)

Special master did not err by basing willful infringement finding on conduct surrounding defendant's theft of trade secrets from plaintiff prior to issuance of patent in suit, even though willfulness is generally based on post-issuance conduct, since pre-patent conduct may also support finding of willfulness, since willfulness determination requires examination of totality of circumstances, and since conduct in question was



only one of many criteria relied upon by master; master's finding that defendant's in-house counsel, who rendered opinion that plaintiff's patent was invalid, was involved in misappropriation further supports finding of willfulness, as does defendant's knowledge of commercial and technological significance of patent, knowledge that its products were derived from plaintiff's technology, pattern of copying plaintiff's innovations, and intense business and technical rivalry with plaintiff.

**Particular patents — General and mechanical — Casting material**

4,502,479; Garwood and Kathiriya, water-activated casting material; judgment holding claims 1-4 and 8 valid, enforceable and infringed; affirmed.

4,667,661, Scholz, Bartizal, Reed, Larson, Ersfeld, Sandvig and Buckanin, curable resin coated sheet having reduced tack; judgment holding claims 12 and 17 valid, enforceable, and willfully infringed; affirmed.

4,774,937, Scholz, Bartizal, Reed, Larson, Ersfeld, Sandvig and Buckanin, curable resin coated sheet having reduced tack; judgment holding claims 3, 4, 10, 11, 12, 18, 21 and 43 valid, enforceable, and willfully infringed; affirmed.

**Particular patents — Chemical — Casting material**

4,609,578, Reed, resin-coated extensible heat-set fiberglass knit tape; judgment holding claim 1 valid, enforceable and willfully infringed; affirmed.

**Appeal from the U.S. District Court for the District of Minnesota.** Murphy, J.: 22 USPQ2d 1401.

Action by Minnesota Mining and Manufacturing Co. against Johnson & Johnson Orthopaedic Inc., for patent infringement, misappropriation of trade secrets, theft, and receipt of stolen property, in which defendant counterclaims for antitrust violations, fraudulent procurement, unfair competition, deceptive trade practices, and declaration of patent invalidity and unenforceability. From federal district court's adoption of special master's report finding patents valid and infringed and awarding increased damages, and from entry of permanent injunction, defendant appeals. Affirmed.

Frank P. Porcelli, of Fish & Richardson, Boston, Mass. (Gregory A. Madera, Robert C. Nabinger, and Mark J. Hebert, Boston; David C. Forsberg, Karen D.

McDaniel, and Kathleen E. DiGiorno, of Briggs & Morgan, St. Paul, Minn., with him on brief; Carolyn A. Bates and Terryl K. Qualey, St. Paul, of counsel), for plaintiff.

Stephen B. Judlowe, of Hopgood, Calimafde, Kalil, Blaustein & Judlowe, New York, N.Y. (David F. Dobbins and Harman A. Grossman, of Patterson, Belknap, Webb & Tyler, New York, with him on brief; Eric I. Harris, New Brunswick, N.J., of counsel), for defendant.

Before Smith, senior circuit judge, and Rich and Rader, circuit judges.

**Rich, J.**

Johnson & Johnson Orthopaedics, Inc. (JJO) appeals from the judgment of the United States District Court for the District of Minnesota, Fourth Division, Civil Action No. 4-86-359, holding JJO liable for infringement of claims 1-4 and 8 of U.S. Patent No. 4,502,479, issued to Garwood *et al.* in 1985 (the Garwood patent); willful infringement of claim 1 of U.S. Patent No. 4,609,578, issued to Reed in 1986 (the Reed patent); willful infringement of claims 12 and 17 of U.S. Patent No. 4,667,661, issued to Scholz *et al.* in 1987 (the Scholz patent); and willful infringement of claims 3, 4, 10, 11, 12, 18, 21 and 43 of U.S. Patent No. 4,774,937, issued to Scholz *et al.* in 1988 (the Scholz II patent). The patents relate to orthopedic casting tapes and, more specifically, to resin based casting systems which have replaced plaster casts. The district court awarded Minnesota Mining And Manufacturing Co. (3M) damages of \$53,636,348 and prejudgment interest in the amount of \$9,525,000 and also awarded double damages based on JJO's willful infringement. We affirm.

## BACKGROUND

### A. The District Court Opinion

This case originally involved four U.S. patents and was tried before a Special Master, Janice M. Symchych (the Master). The lawsuit was filed by 3M against JJO alleging willful infringement of the four above-mentioned patents; misappropriation of trade secrets; theft; and receipt of stolen property. JJO counterclaimed for violation of antitrust laws and a declaratory judgment of patent invalidity and unenforceability on the four patents, as well as damages for fraudulent

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The trial lasted thirty-four days, involved the testimony of 32 witnesses and over one thousand evidentiary exhibits, and resulted in 435 findings of fact and 86 conclusions of law made by the Master. The Master's findings of fact/conclusions of law and memorandum opinion are set forth at *Minnesota Mining and Mfg. Co. v. Johnson & Johnson Orthopaedics, Inc.*, Civil Action No. 486-359, 1991 U.S. Dist. LEXIS 11451 (D. Minn., Fourth Div. April 30, 1991) and 1991 U.S. Dist. LEXIS 14823 (D. Minn., Fourth Div. April 30, 1991), respectively. The Master's decision was reviewed by the district court in connection with the parties' motions related to the Master's report. These motions included JJO's opposition to the Master's report.

The district court subsequently issued an opinion dated July 26, 1991, based on the Master's findings of fact, conclusions of law, and memorandum opinion holding that the Garwood, Reed, Scholz and Scholz II patents are valid and enforceable, and that JJO infringed claims of all four patents. All of JJO's counterclaims were dismissed with prejudice. Damages and interest as above stated were awarded. Finally, the district court enjoined JJO from continued infringement of the patents in suit.

Since the district court adopted the Master's findings, we refer to the district court's findings in this opinion as the Master's findings. On appeal, JJO challenges the Master's findings that: (1) the Scholz and Garwood patents are valid and infringed; (2) there was no inequitable conduct committed by 3M during the prosecution of the Scholz and Reed patent applications before the U.S. Patent and Trademark Office (PTO); (4) JJO willfully infringed the Scholz and Reed patents; and (5) 3M was entitled to the award of damages amounting to \$53,636,348 (before doubling).

#### B. General Technology

The inventions involved in this case relate to synthetic orthopedic casting tapes which have replaced plaster of paris bandages which had been the preferred means used to immobilize broken or fractured bones for over a century. Plaster casting tapes are activated by dipping and squeezing them in water which causes them to become creamy and smooth. In this state, the bandages can easily be rubbed and smoothed in order to shape the cast around the area of a broken or

fractured bone. The bandages are then allowed to harden to form a solid cast.

Plaster of Paris casts were originally preferred because they are easy to apply and mold around broken limbs. However, plaster casts suffer from several drawbacks because they are slow to harden, heavy, relatively nonporous, do not allow the skin to "breathe," and readily break down when exposed to water.

During the 1970s, several attempts were made in the casting field to develop a synthetic casting product that would retain the advantages of plaster (i.e., its slipperiness and smoothability) while overcoming its drawbacks by being lightweight, porous, quick to harden, and water resistant. Two main components were involved in these developments. The first was a substrate or backing which comes in the form of a knitted or woven fabric (i.e., a scrim) cut into narrow strips or tapes; the second was a resin which is coated on or impregnated in the substrate and hardens after it is activated.

Three major players in the synthetic casting industry — 3M, JJO, and Cutter Biomedical (Cutter), a U.S. subsidiary of Bayer A.G. (Bayer), a German Chemical Company — evolved in the market, each hoping to develop a synthetic cast that would replace plaster of paris as the industry standard. Ultimately, 3M and JJO became the industry leaders, obtaining a combined market share of about 70-90% from 1985 to 1991. However, based on the Garwood, Reed, Scholz, and Scholz II inventions, 3M emerged as the undisputed industry leader, controlling approximately half the market from 1985 to 1991. With each new invention, 3M introduced a new casting product. JJO would then copy the product and introduce a corresponding competitive casting product. The level of competition rose to the point where, in November, 1985, JJO obtained trade secrets stolen from 3M by Philip Stegora, a 3M chemist. These were samples of 3M's slippery resin product disclosed in the Scholz and Scholz II patents, which had not yet issued. JJO analyzed the samples and later filed a patent application based on technology culled therefrom.

#### C. The Garwood Patent

The Garwood patent discloses an improved orthopedic casting material, invented by Dr. Donald C. Garwood and Dr. Shiraz A. Kathiriya, which is strong, lightweight, porous, and quick curing. The material is obtained by combining knit fiberglass fabric from 0.020-0.045 of an inch thick and having 20-200 mesh openings per square inch with a water-curable polyurethane prepolymer res-

in described in U.S. Patent No. 4,376,438, issued March 15, 1983 to Straube et al. (the Straube patent).

#### D. The Reed Patent

The Reed patent discloses a method for obtaining an improved resin coated casting tape, invented by Dr. Katherine Reed, which is comprised of a knitted fiberglass fabric that is heat-set essentially without tension (i.e., in a relaxed state) in order to retain a substantial portion of its extensibility or stretchability (i.e., at least 20 percent in the lengthwise direction prior to curing) while eliminating or preventing frayed ends on the fabric which become sharp and needle-like when the resin hardens. The patent claims both a method and apparatus.

Dr. Reed discovered that if fiberglass is heat set in a relaxed state, a fabric is obtained which retains a substantial amount of its extensibility and will be free of frayed ends when cut. Prior to this discovery, persons in the casting art were forced to choose between a fabric having one or the other, but not both features.

#### E. The Scholz Patent

The Scholz patent discloses a curable resin coated sheet (i.e., such as casting tape) which includes an additive lubricant at a major surface of the sheet, present in an amount sufficient to reduce the kinetic coefficient of friction (KCOF) of the casting tape to less than about 1.2. The patent sets forth a test for determining the KCOF of a casting tape.

Dr. Reed and Dr. Matthew Scholz discovered that including lubricants in the resin reduces the tackiness or stickiness of the casting tape surface by making the resin slippery. In this state, the cast can be rubbed and smoothed during the application process. In addition, although the resin was slippery the casting tape layers retained their ability to bond together (i.e., the layers do not delaminate).

## II. DISCUSSION

#### A. The Scholz Patent

##### 1. Anticipation

JJO alleges that claims 12 and 17 of the Scholz patent are anticipated by a number of prior art, commercial, casting tape products and U.S. and Japanese patents. Claims 12 and 17 read:

12. An article comprising a curable resin-coated sheet having a lubricant at a major surface of the coated sheet, wherein said lubricant comprises an additive which is a mixture of any of the compositions selected from the group consisting of a surfactant, a polymer comprised of a plurality of hydrophilic groups, and a polysiloxane, and wherein said lubricant is present in an amount such that the kinetic coefficient of friction of the coated surface of the sheet material is less than about 1.2.

17. An article comprising a pre-lubricated curable resin-coated sheet wherein the curable resin is a water-curable isocyanate-functional prepolymer which is a derivative of an aromatic polyisocyanate and wherein a major surface of the sheet exhibits a kinetic coefficient of friction of less than about 1.2.

According to JJO, each of the prior art casting products and references either teach or contain chemical compositions such as silicone and polyethylene which are lubricants identified in the Scholz patent and, therefore, meet the respective claim limitations in claims 12 and 17. JJO's argument centers on the claim language "a lubricant at a major surface of the coated sheet" in claim 12 and "a pre-lubricated curable resin-coated sheet" in claim 17. According to JJO, the claims were interpreted so as to include an additional and extraneous "slipperiness" limitation. In other words, the claims only require the presence of a lubricant, but were erroneously interpreted by the Master to require some degree of slipperiness. As a result of this interpretation, JJO argues, the prior art items disclosing the presence of a lubricant in a casting system were rejected by the Master because they were not slippery.

[1] A party asserting that a patent claim is anticipated under 35 USC 102 "must demonstrate, among other things, identity of invention." *Kalman v. Kimberly-Clark Corp.*, 713 F.2d 760, 771, 218 USPQ 781, 789 (Fed. Cir. 1983), cert. denied, 465 U.S. 1026 [224 USPQ 520] (1984), overruled in part on another ground, *SRI Int'l v. Matsushita Elec. Corp. of Am.*, 775 F.2d 1107, 1125, 227 USPQ 577, 588-89 (Fed. Cir. 1985) (in banc). Identity of invention is a question of fact, and one who seeks such a finding must show that each element of the claim in issue is found, either expressly or under principles of inherency, in a single prior art reference, or that the claimed invention was previously known or embodied in a single prior art device or practice. *Id.* As a question of fact, the district court's finding is subject to review under the clearly erroneous standard.



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17. JJO's argument  
guage "a lubricant at  
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According to JJO, the  
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*Tyler Refrigeration v. Kysor Indus. Corp.*,  
770 F.2d 687, 690, 227 USPQ 845, 847  
(Fed. Cir. 1985).  
[2] To review the district court's finding,  
we first have to construe the claims. *Kalman*,  
713 F.2d at 771, 218 USPQ at 789. Claim  
construction is a question of law. However,  
when the meaning of key terms of the claim  
is disputed, as in this case, and extrinsic  
evidence is necessary to explain the terms,  
then underlying factual questions may arise.  
*Johnston v. IVAC Corp.*, 885 F.2d 1574,  
1579, 13 USPQ2d 1382, 1385 (Fed. Cir.  
1989). When the interpretation of claims  
requires findings of underlying facts, those  
factual findings are reviewed in accordance  
with the appropriate evidentiary standard,  
i.e., that of clear error. *Perini America, Inc.*  
*v. Paper Converting Machine Co.*, 832 F.2d  
581, 584, 4 USPQ2d 1621, 1624 (Fed. Cir.  
1987).  
a. Claim Interpretation.—The Meaning  
of the Terms "Lubricant" and  
"Pre-lubricated"  
The Master rejected JJO's argument be-  
cause the chemicals, although present in the  
prior art, were used for other non-lubricating  
functions and did not "lubricate" as this  
term is understood from the Scholz specifica-  
tion. The Master found that the prior art  
cited by JJO either exhibits or teaches a  
casting system that uses or describes the  
tacky resin technology. As a result, they  
either teach or exhibit a tacky resin that  
cannot be smoothed during the molding pro-  
cess as required by the claimed invention.  
Although there is no express limitation in the  
claims of "smoothed during the molding pro-  
cess," that property is an aspect of "having a  
lubricant at a major surface" or being  
"pre-lubricated."  
The Master concluded that the claims  
should be interpreted in accordance with  
their relation to a casting tape which is  
prelubricated and exhibits a low KCOF be-  
cause the lubricant has caused the resin on  
the tape to become slippery when activated.  
Although the word "slippery" is not found in  
the claims, the Master found it necessary to  
use the specification in order to determine  
what the inventor meant by terms and  
phrases in the claims. This is entirely proper.  
*E.I. Du Pont de Nemours & Co. v. Phillips*  
*Petroleum Co.*, 849 F.2d 1430, 1433, 7  
USPQ2d 1129, 1131 (Fed. Cir.), cert. de-  
nied, 488 U.S. 986 (1988). In defining the  
meaning of key terms in a claim, reference  
may be had to the specification, the prosecu-  
tion history, prior art, and other claims.  
*Tandon Corp. v. International Trade*  
*Comm'n*, 831 F.2d 1017, 1021, 4 USPQ2d

1283, 1286 (Fed. Cir. 1987). This is not,  
however, to be confused with reading into a  
claim a limitation appearing in the specifica-  
tion but not in the claim. *E.I. Du Pont de*  
*Nemours*, 849 F.2d at 1433, 7 USPQ2d at  
1131.  
The fundamental purpose and significance  
of the Scholz invention is to produce a non-  
sticky or non-tacky resin (i.e., a slippery  
resin) to permit smoothing and forming of  
the casting tapes, thereby overcoming the  
"tacky resin" problem of the prior art. This  
is evident throughout the patent specifica-  
tion. In the background section of the speci-  
fication, Scholz describes the problems that  
existed with prior art resins used on orthope-  
dic casting tapes:  
[T]hese resins are quite tacky until cured.  
This tackiness makes it difficult to mold  
the cast to the patient's limb as the resin  
tends to stick to the protective gloves worn  
by the cast applicator. For example, after the  
rolls are wrapped but before they harden,  
some working time is necessary in order to  
mold the casts to fit the limb. This is  
accomplished by smoothing the cast with a  
gloved hand as well as holding the cast at  
certain points until it hardens. When a roll  
of tapes coated with a tacky resin is used,  
molding the cast is difficult. The reason  
for this difficulty is that the glove sticks to  
the resin and when attempts are made to  
smooth the cast and form it, the layers  
of tape pull apart from each other, thus  
requiring reforming of part of the cast.  
To overcome these problems, Scholz iden-  
tifies different lubricants and how they are  
used to reduce the tackiness or stickiness of  
the surface of the casting tape by making the  
resin slippery. This in turn allows the ban-  
dages to be smoothed in various directions as  
is done with plaster of paris casts. The speci-  
fication is replete with examples of how the  
lubricants are selected and what they accom-  
plish. With respect to one type of lubricant,  
the specification states:  
One aspect of this invention is a sheet,  
e.g., a scrim, coated with a curable resin  
wherein one or more hydrophilic groups  
are chemically bound to the resin. When  
this orthopedic casting material is brought  
into contact with water, the hydrophilic  
group causes the resin to become slippery.  
The specification also evaluates and distin-  
guishes between different additive lubricants  
JJO acknowledges this purpose in its brief  
when it states "[i]ndeed, the entire purpose and  
only purpose of the invention is to render the  
surface of the casting tape slippery so as to  
facilitate smoothing during application."

to determine which ones are better able to reduce the tackiness of the resin:

Unlike the materials discussed above, the silicone based fluids dramatically reduced the tackiness of the resin and surprisingly did not affect the other properties of the cast and even at elevated temperatures remained on the surface of the resin and remained slippery.

The specification further describes and refers to various lubricants that "yield the desired non-tacky or slippery casting materials," "[cause] the resin to become slippery," "give a non-tacky and even slippery feeling surface," "[remain] on the surface of the resin and [remain] slippery," and "enhance the slippery feel of the casting tape."

Finally, overcoming the problems experienced in the prior art, the Scholz patent describes how the lubricated casting tape is used:

When immersed in water, the tapes quickly become very slippery. The rolls unwind easily and do not stick to gloves. After the roll is wrapped around the limb, molding of the cast becomes easy due to the non-tacky nature of the resin. The cast can be rubbed over its entire length without sticking to the gloves and the layers of tape do not separate from each other. This pre-lubricating resin approaches the handling characteristics of plaster of Paris bandages very closely.

[3] Based on our review of the specification, it is quite clear the Master did not read an extraneous limitation into the claims. What the patentee meant by the term "lubricant" and the phrase "pre-lubricated resin coated sheet" is evident from the specification. To speak of "a lubricant at a major surface of the coated sheet" or "a pre-lubricated curable resin-coated sheet," especially in light of the specification's emphasis on obtaining a slippery feel or slippery surface, means exactly what one would expect when a lubricant is placed on a surface — that the surface is slippery. Accordingly, we find that the Master's interpretation of the claims is correct.

JJO's next argument is that this interpretation renders the claims indefinite because it is impossible to know how "slippery" the product has to be. However, JJO's argument is improperly framed in its use of the term "slippery" because this term is not used in the claims. The claims only require lubrication. The term "slippery" was used by the Master to define and explain what was meant by the term "lubricant."

The amount of lubrication required is laid out in the specification and should be sufficient to achieve the fundamental purpose of

the invention — the ability to smooth and rub the casting materials during molding without the resin and tape sticking to the applicator's hands. In addressing a similar issue, this Court in *Bausch & Lomb, Inc. v. Barnes-Hind/Hydrocurve, Inc.*, 796 F.2d 443, 450, 230 USPQ 416, 421 (Fed. Cir. 1986), *cert. denied*, 484 U.S. 823 (1987), ascertained the meaning of the term "smooth" based on a review of extrinsic evidence:

Disputed issues such as the meaning of the term "smooth," should be construed by resort to extrinsic evidence such as the specification, other claims, and the prosecution history. Here, resort to the specification clearly demonstrates that "smooth" meant that "the edges of the lenses neither inflame nor irritate the eyelid of the lens wearer \* \* \*." ... Testimony from Dr. Mandell, Bausch & Lomb's expert in the field of contact lenses, indicates that to a person of ordinary skill in the art, smooth would mean an absence of "roughness or significant elevation" so that a wearer "would not feel it with the [eyelid]." ...

We hold that smooth means *smooth enough to serve the inventor's purposes*, i.e., not to inflame or irritate the eyelid of the wearer or be perceived by him at all when in place. [Emphasis ours.]

Likewise, we do not perceive any difficulty or confusion in determining what is "lubricated" and what is not lubricated in terms of the Scholz patent. That is, lubricated products are products that can be rubbed and smoothed to allow molding of the cast without the resin and tape sticking to the applicator's hands or gloves.

#### b. Claim Interpretation — Whether the Master Required the KCOF to be Calculated on a "Standard Substrate"

JJO's next argument is that the Master's findings indicate that her interpretation of the claims erroneously requires a "standard substrate" limitation. This argument relates to the claim limitation requiring "a KCOF of less than about 1.2." According to JJO, the Master required the KCOF to be calculated using the same type of substrate or scrim that is used in the Scholz patent in order to determine whether the prior art anticipated (i.e., had a KCOF of less than about 1.2) and then failed to require the use of the same type of substrate to determine infringement.

[4] JJO relied on a number of individual "findings of fact" (FF) made by the Master which, when read out of context with the Master's entire findings, appear to support



JJO's argument. However, when the findings are reviewed in context, their meaning is clear. We address two of them here.

In FF-73 the Master states:

FF-73. The Scholz patent sets forth a test for determining the KCOF of a casting tape. The test method is based on the American Society for Testing Materials Standards, ASTM D-1894, "Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheet," which is referenced in the patents. The test is conducted by pulling a special "sled" a specified distance of travel along the length of an 18 to 24 inch sample of tape. *The KCOF test can be used to compare the relative slipperiness of resins. A person of ordinary skill in the art understands that to accurately compare resins, the serims [sic] of the casting tapes upon which the resins are applied must be the same.* [Emphasis ours.]

The Master does not say that to find infringement or anticipation the KCOF must be determined on a particular scrim. The Master merely found that the KCOF can be used to compare the relative slipperiness of the resins. This finding is used by the Master to address whether 3M was guilty of inequitable conduct.

JJO cites FF-315, also out of context, in support of its argument:

FF-315. Scotchflex XF and Red Label registered low KCOF values because their fabric substrates were different from the substrate used in all tests and examples submitted with the Scholz applications. Scholz teaches a pre-lubricated resin system, and is unrelated to fabric substrate. *Accordingly, to obtain an accurate comparison of resin slipperiness, it is essential to keep the substrate constant.* [Emphasis ours.]

This finding also relates to the inequitable conduct issue and why it was not necessary for 3M to report certain prior art to the PTO during 3M's prosecution of the Scholz patent. The Master was not interpreting the

The KCOF value is a function of at least two variables — the resin and the surface of the scrim — meaning that the KCOF can be affected by changing the tackiness of the surface (changing the resin) or the roughness of the surface (changing the scrim). This finding is supported by the specification and the testimony of William Van Santen, JJO's expert witness called to testify on the inequitable conduct issue.

3M has conducted KCOF tests on two commercial products, Scotchflex XF and JJO's Red Label product, and found that they had surface KCOF values of 1.25 and 1.47, respectively. 3M did not report this data to the PTO and had

claims to require a constant substrate, but merely explaining why 3M's failure to report the test data to the PTO did not constitute inequitable conduct — the two products were part of the sticky prior art and were not pre-lubricated. The relative insignificance of the unreported prior art was shown when the resins were tested on the same substrate used in the Scholz patent and produced KCOFs well above 1.2. JJO should have understood this because it is explained in FF-314, FF-316 and FF-317, none being mentioned in JJO's analysis. Thus, the Master did not require that the KCOF be calculated on a standard substrate.

### c. Analysis of the Prior Art

[5] Having determined the proper construction of the claims, the Master went on to determine that the patents and commercial products identified by JJO did not anticipate the Scholz patent. Because these findings are addressed in detail in the Master's report, we touch on them only peripherally here. The chemicals that JJO alleges are lubricants do not anticipate because they are either used in the wrong form or in too small an amount to function as lubricants as required by the claims. For example, silicone, identified in the Scholz patent as a lubricant, is described in the prior art and used in a number of commercial products. However, the Master found, among other things, that silicone is used and described in the prior art as an anti-foaming agent and in an amount insufficient to serve as a lubricant that prevents the resin from becoming tacky during molding.

represented that the nearest prior art KCOF was 1.76. JJO argued that 3M's failure to report the test data (i.e., the KCOF values of 1.25 and 1.47) constituted inequitable conduct rendering the Scholz patent unenforceable.

We also note that JJO's argument incorrectly implies that the low KCOF limitation is equivalent to finding that the casting tape is lubricated. A low KCOF under about 1.2 is a limitation in the claims, and is therefore a necessary condition of both infringement and anticipation. But it is not a sufficient condition of either. The product must also be lubricated which, contrary to the way JJO would have us interpret the claims, is not the same as a low KCOF which does not, in and of itself, establish that the product is lubricated.

The amount of silicone measured in one prior art product known as UltraCast and in 3M's prior art commercial products, Scotchflex XF and Scotchcast Reinforcing Strip, amounts to 0.7% and 0.18% of the resin, respectively. The amount of silicone in the JJO products was even less.

The Master also found that this was JJO's understanding of the prior art. JJO represented in the patent application it filed based on the misappropriated trade secrets that prior art polyurethane resin often included 0.1-1% silicone as an antifoaming agent and does not suggest that in such small amounts silicone reduces the tackiness of the resin.

With one exception, each of the products identified by JJO was demonstrated at trial and each displayed a tacky resin. The Master found that, even though some of the prior art products had KCOF values below 1.2, none was shown to include pre-lubricated resins or to have a lubricant at a major surface.

Likewise, the Master rejected other resins alleged to be anticipatory that included chemicals that, although identified as lubricants in the Scholz patent, were used in different forms that did not function or act as lubricants. For example, the prior art describes a polyurethane resin that uses a polyethylene oxide in liquid form the purpose of which is to draw water into the resin to promote a fast cure. However, as set forth in the Scholz patent, liquid forms of polyethylene oxide do not work as lubricants in polyurethane resins.

The Master found these findings were also in line with the representations made by JJO to the PTO during the prosecution of its slippery resin patent application. Finally, variations of the prior art resins containing polyethylene were demonstrated at trial and all were shown to be sticky. Thus, the Master found the resins did not include a lubricant and were not pre-lubricated. Accordingly, we find no clear error in the Master's decision that the Scholz patent is not anticipated.

## 2. Inequitable Conduct

[6] JJO alleges that 3M intentionally withheld material prior art, which 3M knew had KCOF values at or near 1.2, from the PTO and that this alleged misconduct independently "invalidates" the Scholz patent. First, we note that proving inequitable conduct does not "invalidate" a patent. Rather, it renders the patent unenforceable. *Kingsdown Medical Consultants Ltd. v. Hollister Inc.*, 863 F.2d 867, 877, 9 USPQ2d 1384, 1392 (Fed. Cir. 1988). Although the practical effect may be the same, the legal concepts are quite different.

Second, a finding of inequitable conduct is committed to the discretion of the trial court and is reviewed by this court under an abuse of discretion standard. *Kingsdown*, 863 F.2d at 876, 9 USPQ2d at 1392. To overturn a discretionary ruling of a district court, the

appellant must establish that the ruling is based upon clearly erroneous findings of fact or a misapplication or misinterpretation of applicable law or that the ruling evidences a clear error of judgment on the part of the district court. *Id.*

The Master found that JJO failed to prove that the prior art was material or that 3M intended to deceive the PTO. JJO has failed to convince us that the Master's findings are clearly erroneous or that the Master misapplied or misinterpreted any law.

## 3. Infringement of the Scholz Patent

A determination of patent infringement under 35 USC 271(a) requires a two-step analysis — first, the language of the claim at issue must be interpreted to define its proper scope and second, the evidence before the court must be examined to ascertain whether the claim has been infringed, whether the claim "reads on" the accused product or process. The first inquiry is a question of law for the court while the second is a question of fact. *C.R. Bard, Inc. v. Advanced Cardiovascular Sys.*, 911 F.2d 670, 673, 15 USPQ2d 1540, 1543 (Fed. Cir. 1990); *Standard Oil Co. v. American Cyanamid*, 774 F.2d 448, 452, 227 USPQ 293, 295-96 (Fed. Cir. 1985).

For infringement purposes the Master classified JJO's slippery resin products into two categories, the S-Thane products and the U-Thane products, based on the name of the two resins the products used. The S-Thane resin was introduced in September 1986 and used until September 1990 when JJO started using a new slippery resin called U-Thane. The Master found that both the S-Thane and U-Thane casting tape products literally infringed claims 12 and 17 of the Scholz patent and that the U-Thane products also infringed under the doctrine of equivalents.

On appeal of the infringement issue JJO again argues that the Master construed the claims for validity purposes, to require the KCOF measurements to be taken on a standard substrate and failed to do the same in her infringement determination. Relying on this premise, JJO argues that there is no evidence of infringement because the KCOF values obtained on its S-Thane and U-Thane products were not determined on the standard substrate. As we have already determined in our review of JJO's anticipation defense that the tribunals below made no such error, we find it unnecessary to address this issue again except with respect to testimony offered by JJO in further support of its argument. With respect to this testimony we note

the ruling is findings of fact interpretation of evidence as a part of the

failed to prove that 3M JO has failed its findings are Master misap-

#### Patent

infringement is a two step of the claim to fine its proper before the to retain whether the product or question of law a question of Standard Oil 74 F.2d 448, Fed. Cir.

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only that it, like the findings of fact used to support JJO's anticipation defense, was taken out of context of what a fair reading indicates was actually said.

Furthermore, we note that there is no question the S-Thane products infringe because this was conceded by JJO prior to trial. In its pre-trial Case Analysis report submitted to the court, JJO admitted that, if the Scholz patent is valid, then JJO's S-Thane products infringe. Therefore, we turn our attention to JJO's argument that there is insufficient evidence to support the Master's finding that JJO's U-Thane products infringe claims 12 and 17 of the Scholz patent.

The issue here turns on the second part of the infringement analysis — whether the Master clearly erred in finding that JJO's U-Thane products have at least one major surface exhibiting a KCOF of less than about 1.2. There is no dispute that the U-Thane products meet all other limitations of claims 12 and 17.

To prove their respective positions, both JJO and 3M conducted KCOF tests using the U-Thane resin except that 3M conducted its tests on actual batches of commercial U-Thane products while JJO conducted its tests on U-Thane resin applied to factory experiment casting tape. The Master's findings indicate that after running two sets of tests, 3M obtained an average KCOF of 0.86 for the back side of the tape (facing the inside of the roll) and an average KCOF value of 1.12 for the face side of the tape (facing the outside of the roll). JJO obtained a combined average KCOF for both sides of the tape of 1.59. The Master credited 3M's data as more reliable than JJO's because 3M conducted its tests in accordance with the directions in the Scholz patent and on commercial batches of JJO casting tape while JJO's data was generated from tests conducted on experimental tape.

On appeal, JJO presents two reasons why it believes the KCOF values obtained by 3M are unreliable and, therefore, erroneously relied on by the Master. First, JJO argues that 3M failed to take an equal number of readings in each direction and therefore the averages are unreliable. Second, JJO argues that the samples used to conduct 3M's tests were defective because they exhibited pooling or puddling of the resin and therefore rendered the test results unreliable. Our re-

The rolls of tape must be packaged under controlled conditions. If the temperature is not controlled and the rolls are exposed to too much heat, the exposed resin will thin out and puddle at one end of the roll.

view of the test results in connection with the Master's findings lead us to conclude that the Master's decision is not clearly erroneous.

The Master's findings indicate that the KCOF can be determined by taking either an average or mean value of sled readings. Although readings must be taken in both directions, there is no requirement that the number of readings in each direction must be equal. JJO has failed to identify any evidence to suggest otherwise. Under the ASTM method referenced in the patent, the test is conducted a sufficient number of times to determine the mean or average KCOF value of a surface, and it is the mean value which is reported. The patent states with sufficient clarity that it is the average or mean KCOF value of a major surface that is to be determined and any directional effects will be accommodated by the processes of averaging.

Although we recognize that an even number of readings taken in both directions might result in a more accurate result, we also note that one reading short in one direction does not necessarily render the KCOF value obtained unreliable or inaccurate. This is quite apparent from a comparison of the KCOF values obtained for the back side of the tapes in 3M's June 1990 and September 1990 tests wherein the September 1990 test was based on an equal number of values taken in both directions. The KCOF values obtained under both methods are virtually the same (i.e., .85 and .87, respectively). Thus, under either method, at least one side of the product had a KCOF averaging below 1.2, thereby meeting the claim limitation of claim 17 ("wherein a major surface of the sheet exhibits a kinetic coefficient of friction of less than about 1.2").

JJO's second argument also does not establish that the Master clearly erred in making its infringement decision. In 3M's June 1990 test 3M obtained an average KCOF of 0.69 for the face side of the tape. In 3M's September 1990 test, run on samples produced by JJO pursuant to a court order, 3M obtained an average KCOF of 1.27 for the face side. Dr. Reed attributed the difference in the results to the condition of the samples produced by JJO testifying that the samples were not produced in their original containers and exhibited a significant amount of resin puddling on the rolls. When all the values were combined and averaged the

The record reveals that 3M issued a subpoena requesting additional samples, but that JJO refused to provide any.



KCOF value for this side of the tape was 1.12. Relying on this KCOF value, the Master again determined that JJO's products infringed. In contrast to the test results presented by 3M, JJO offered test results showing that the KCOF of its U-Thane products is over 1.2. JJO tested its product a total of eleven times, and in every case, the average KCOF for each side exceeded 1.2.

[7] In view of the different results and conflicting evidence produced by 3M and JJO, the Master was forced to make a credibility determination as to which results were more reliable. This determination was expressly made in favor of 3M because she deemed the results obtained from 3M's tests, made on rolls taken from commercial batches of product sold by JJO, more reliable than the results obtained from JJO's data generated from tests conducted on factory experiments. The Master's findings also indicate that she believed that 3M's tests were conducted in accordance with the procedures outlined in the Scholz patent.

We find no clear error in the Master's decision and, accordingly, affirm her finding of literal infringement. Having affirmed the Master's finding of literal infringement, we find it unnecessary to consider the Master's finding of infringement under the doctrine of equivalents.

#### B. The Garwood Patent

##### 1. Anticipation

JJO argues that the Master erred as a matter of law by failing to hold claim 1 of the Garwood patent anticipated by the Straube patent. JJO argues that during the prosecution of the Garwood patent 3M reviewed the Straube patent and, based on the information provided, was able to calculate a range of mesh sizes and thickness parameters that encompassed the range of measurements claimed in the Garwood patent. As a result, JJO argues that 3M is now estopped from arguing that Straube does not disclose the measurements claimed in Garwood.

Claim 1 provides: "An orthopedic casting material comprising a fabric made from a fiber having an initial modulus of elasticity greater than  $8 \times 10^6$  pounds per square inch; said fabric having a thickness between 0.020 and 0.045 inch and a mesh size of 20 to 200 openings per square inch and a reactive fluid polyisocyanate prepolymer resin impregnated in said fabric which hardens when said resin is wetted with water."

Absence from the Straube patent of any claimed element negates anticipation. *Atlas*

*Powder Co. v. E.I. Du Pont De Nemours & Co.*, 750 F.2d 1569, 1573-74, 224 USPQ 409, 411 (Fed. Cir. 1984).

The Master found no anticipation because the Straube patent does not include any mesh size or thickness parameter for the knit fiberglass fabric substrate mentioned in the Garwood claim. The Master found that the ranges 3M extrapolated from Straube are "so broad as to be meaningless to one skilled in the art. The Straube patent provides no guidance as to how to construct a fiberglass cast with the beneficial properties achieved by the Garwood invention: strength, porosity, lightness, and ability to cure quickly." The Master recognized that although Garwood's specific claims are subsumed in Straube's generalized disclosure of knit fiberglass as a substrate, this is not literal identity. The Master also relied on the fact that the PTO specifically considered the effect of the Straube patent on the Garwood application. Where the PTO has considered a piece of prior art and issued a patent notwithstanding that prior art, a court owes some deference to the PTO's decision. *American Hoist & Derrick Co. v. Sowa & Sons, Inc.*, 725 F.2d 1350, 1360, 220 USPQ 763, 771 (Fed. Cir.), cert. denied, 469 U.S. 821, 224 USPQ 520 (1984).

[8] We find no error in the Master's determination that Straube does not anticipate. In order to anticipate, the Straube patent must sufficiently describe the claimed invention to have placed the public in possession of it. The record establishes that the Straube patent does not do this. It merely states in a very general way that fiberglass can be used as a substrate. However, neither the information provided in the Straube patent nor 3M's interpretation thereof are exact enough to identify the ranges claimed in Garwood.

##### 2. Obviousness

JJO argues on appeal that it would have been obvious to one of ordinary skill in the art to combine a polyurethane resin and fiberglass substrate with Garwood's thickness and mesh parameters. JJO alleges that the use of the polyurethane resin on fiberglass substrates was disclosed in the Straube patent and in a 1977 article entitled *Development Of A Water-Activated Plastic Cast*, authored by M.J. Lysaght and T.R. Rich (the Lysaght/Rich article).

[9] Whether the claimed invention would have been obvious at the time the invention was made is reviewed *de novo* by this court although the underlying factual inquiries (e.g., the scope and content of the prior art,

level of ordinary skill in the art, and differences between the prior art and the claimed invention) are reviewed under the clearly erroneous standard. *Hybritech Inc. v. Monoclonal Antibodies, Inc.*, 802 F.2d 1367, 1379-80, 231 USPQ 81, 90 (Fed. Cir. 1986), cert. denied, 480 U.S. 947 (1987). In addition, objective evidence such as commercial success, failure of others, long-felt need, and unexpected results must be considered before a conclusion on obviousness is reached. *Id.* Indeed, as then Chief Judge Markey said in *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1538, 218 USPQ 871, 879 (Fed. Cir. 1983): "evidence of secondary considerations may often be the most probative and cogent evidence in the record. It may often establish that an invention appearing to have been obvious in light of the prior art is not."

In spite of the importance that the secondary considerations of commercial success, long felt need, and failure of others played in the considerations of both the PTO and the Master, JJO conspicuously fails to address them. Again, borrowing from Chief Judge Markey's language, we note that JJO "adopts the frequent and foolish appellate ploy of citing only such bits of evidence as may support its view, while ignoring the wealth of evidence that establishes the district court's well-reasoned findings to have been not clearly erroneous." *Datascope Corp. v. SMEC, Inc.*, 879 F.2d 820, 825, 11 USPQ2d 1321, 1324 (Fed. Cir. 1989), cert. denied, 493 U.S. 1024 (1990).

#### a. Scope and Content of the Prior Art

JJO argues that the resin and fiberglass substrate used in the Garwood patent are both disclosed in the prior art and that their combination was suggested by the Lysaght/Rich article. The resin disclosed in Garwood is the same resin disclosed in the Straube patent and used in other commercial products while the fiberglass substrate is the same substrate used in 3M's Lightcast products in 1976.<sup>2</sup> JJO argues that all 3M did was follow the express teachings of the Lysaght/Rich article and combine the two materials.

The Lysaght/Rich article, like the previously discussed Straube patent, recognizes that fiberglass can be used as a scrim or substrate material. However, like the Straube patent, the Lysaght/Rich article

The Lightcast products produced a fiberglass cast using a resin that had to be cured using a cumbersome and expensive ultraviolet lamp. In addition, the curing phase took a long time and the resin had an unpleasant odor.

does so in a very general fashion providing no detail as to how to combine the fiberglass substrate and resin to achieve the results obtained by Garwood. Specifically, the article states:

"Cotton gauze yielded a cast with the tactile feel of a plaster of paris cast while coarse fiberglass gave a more rigid, almost bristly, material (akin to Lightcast). The highest strength-to-weight ratio and best overall 'feel' were achieved with fine-weave fiberglass."

Other than mentioning fiberglass as a possible substrate, the article provides no guidance or detail as to how to solve the problems overcome by the Garwood invention or how to construct a fiberglass cast with the beneficial properties achieved by the Garwood invention.

Neither the Straube patent, for the reasons discussed in relation to JJO's anticipation defense, nor the Lysaght/Rich article disclose the thickness and mesh parameters in claim 1 of the Garwood patent.

#### b. The Level of Ordinary Skill in the Art

Neither party has raised any dispute with the Master's determination of what the level of ordinary skill in the casting art was at the time of the Garwood invention. However, we include it here to the extent that it is a necessary part of our analysis in reviewing the obviousness issue.

[10] The Master determined that the level of ordinary skill in the casting art in 1979 would be a person having knowledge of chemistry equivalent to a bachelor's degree, having additional knowledge of resin systems and their curing mechanisms. Such a person would also have some experience in designing orthopedic casting materials and, more particularly, in developing backings for use in casting materials. Finally, a person of ordinary skill in the casting art would also have some knowledge of the clinical usage of casting materials.

#### c. Secondary Considerations

[11] A long-felt but unsolved need for a workable resin based casting system is established by the attempts and failures of the major players in the casting field—3M, Bayer, Cutter, and JJO. All were attempting to develop a substitute for plaster based casting systems using fiberglass as the substrate, and all but 3M failed. This is uncontested by JJO.

Scientists from Bayer and Cutter, including Dr. Gunther Lehnert, a co-inventor on

the Straube patent, tested different fabrics, including fiberglass, for potential use with the Straube resin. After running into a number of problems, the two companies ultimately concluded that fiberglass was not a suitable casting material to be used with polyurethane resin. For example, Bayer was unable to find a way to get the fiberglass layers to laminate well together when using the polyurethane resin. When the resin hardened the layers of fiberglass tended to crack and separate. Cutter ran into similar problems and was unable to impregnate the fiberglass with resin.

Bayer and Cutter were also unable to solve the problem of excessive foaming which occurred during curing and caused the cast pores to clog ruining the cast's porosity. Both companies subsequently abandoned their efforts in developing a fiberglass based system and put their time and resources into developing a cotton/polyester synthetic cast. In 1978, Cutter began marketing its cotton/polyester synthetic cast under the trade name CutterCast.

JJO's attempts also proved unsuccessful. JJO developed a casting system which uses a fiberglass backing in combination with an acrylamide monomer resin, a dry powder that is very dispersible in water. JJO obtained U.S. Patent No. 4,134,397 issued to Gianakakos *et al.*, and developed a commercial product called Chemicast based on the patent. In September 1989, JJO test marketed the product. However, the product took 24-48 hours to achieve weight bearing strength and became so hot during the curing reaction that it could burn the patients. The product was a failure and rejected by the medical community. As a result, JJO withdrew it from the market and, like Bayer and Cutter, decided to pursue a cotton/polyester synthetic product.

Even after 3M introduced Scotchcast, the commercial embodiment of the Garwood patent, into the synthetic cast market JJO remained skeptical of fiberglass. A JJO scientist analyzed Scotchcast upon its release in early 1980 and concluded in a memo dated February 19, 1980 that "Glass is not my substrate of choice!" Five months later, an official at JJO sent a report to the President of JJO, comparing Scotchcast with JJO's cotton/polyester synthetic product referred to internally at JJO as J-THANE. The report stated that:

The major difference between J-THANE and Scotchcast is that we are pursuing a polyester/gauze substrate, while 3M uses a fiberglass substrate. The basic advantages of the J-THANE fabric are better radiolucency, improved conformability,

and much better polyurethane/substrate bonding. Fiberglass offers the advantages of using fewer layers to immobilize, greater porosity to reduce skin maceration and itching, and a neater finished cast appearance. Best available data indicate that the overall functionality of fabric overshadows these comparative advantages of fiberglass. It has been reported that 3M is thus investigating an effective fabric substrate.

A concurrent R&D project was initiated last week to identify an alternative fiberglass substrate for J-THANE. Should the marketplace show an unexpected preference for the fiberglass material, we will be in a position to market a fiberglass product very rapidly.

The Garwood patent also provided a solution for the foaming problem experienced and left unsolved by Bayer, Cutter, and JJO. Foaming led to poor layer to layer lamination as well as poor porosity. Garwood solved the problem by introducing a silicone anti-foaming agent into the resin system. Prior to the Garwood patent, no orthopedic casting material contained an anti-foaming agent. Bayer, Cutter, and JJO were unable to solve the problem until they became aware of the Garwood patent.

JJO also fails to contest the tremendous commercial success experienced by 3M's Garwood invention embodied in the fiberglass Scotchcast product. Scotchcast revenues increased from \$4.7 million in 1980 to over \$15 million in 1981. The demand for 3M's product upon its release was so great that 3M was forced to operate on back order for 12-16 months.

The cotton based products sold by Cutter and JJO, CutterCast and Black Label, respectively, were rejected in favor of the Scotchcast product and their sales rapidly declined while Scotchcast sales soared. The cotton/polyester fabrics were too weak and pliable to make good casts. So many layers were required to make a strong cast that the cast became non-porous. In addition, both Cutter and JJO had yet to overcome the foaming and delamination problems with their cotton based casts.

At least by 1983, both Cutter and JJO had acknowledged that 3M's fiberglass Scotchcast product was preferred by the market. In JJO's 1983 marketing plan, JJO noted that 3M had displaced Cutter as the market leader and acknowledged the value placed by the market on casts having the beneficial properties achieved by the Garwood invention.

The initial resistance to the price differential between synthetics and plaster of Paris has been overcome. The value of a light-



thane/substrate the advantages mobilize, great maceration and had cast appear indicate that the knit overshadows advantages of fiber knit that 3M is thus fabric substrate.

not was initiated alternative fiber-NE. Should the expected prefer-terial, we will be berglass product provided a solu-ent, experienced Cutter, and JJO. to layer lamina-Garwood solved a silicone anti-system. Prior to hopedic casting foaming agent, unable to solve me aware of the tremendous ended by 3M's ed in the fiber-Scotchcast rev-illion in 1980 to the demand for se was so great e on back order sold by Cutter lack Label, re- favor of the in sales rapidly les soared. The e, too weak and So many layers ng cast that the addition, both overcome the problems with ter and JJO had erglass Scotch- the market. In JJO noted that he market lead- ie placed by the neficial proper- invention. e price differen- plaster of Paris alue of a light-

weight, waterproof, impact-resistant, casting material offsets the differential in price.

JJO's marketing plan also noted that Cutter had accepted the fact that fiberglass was preferable to cotton as a casting material. The Master's finding that the commercial success of Scotchcast which is water resistant, lightweight, strong, porous and cures quickly is due to the technical merits of the product is supported by ample testimony in the record and is left uncontested by JJO.

Finally, unable to compete with the overwhelming popularity of 3M's Scotchcast product, JJO and Cutter decided to copy it. JJO copied the Garwood invention when it introduced its Red Label product. Cutter decided to produce a fiberglass product called C-Cast which Burton Dahlen, a former Cutter scientist and manager, admitted at trial was a copy of Scotchcast. Dr. Lehner at Bayer abandoned his position that fiberglass would not work with the Straube resin, and Bayer ultimately determined, after reviewing its own Straube patent, that it should take a license under the Garwood patent.

3M stresses the "real world" situation to support the Master's finding of non-obviousness. In the present case, such real world considerations provide a colorful picture of the state of the art, what was known by those in the art, and a solid evidentiary foundation on which to rest a nonobviousness determination. We do not find the Master's findings of fact erroneous. Accordingly, we agree with her conclusion of law that the Garwood patent would not have been obvious to one of ordinary skill in the art at the time of the Garwood invention.

**Infringement**—The issue of infringement centers on whether the Master properly construed claim 1. The Master interpreted the language "a mesh size of openings per square inch" to mean the spaces in the knit fabric defined or bounded by the courses (the horizontal elements or threads that run across the fabric) and the wales (the vertical elements or threads that run lengthwise of the fabric).

JJO argues that the Master's infringement finding is based on an erroneous claim construction because an "opening" should be interpreted in functional terms to mean any orifice large enough to allow water, air and moisture to pass through and that the knit fabric it uses is not covered by the claim because it has an array of "curved open

loops" intertwined in a horizontal and vertical pattern. These curved loops, JJO argues, should be counted as "openings." When the loops are counted JJO's fabric has more than 500 openings per square inch, through which water and air can pass and, therefore, its products do not infringe. To support its interpretation, JJO relies on the following language in the Garwood patent:

The fabric should be a mesh, i.e., it should have openings through it to enable the curing agent to penetrate into the roll and expose all parts of the resin. Openings in the fabric also facilitate circulation of air through the finished cast and evaporation of moisture from beneath the cast.

It is undisputed that a decision on whether JJO's product infringes claim 1 rests on how the claim is interpreted. If we interpret "openings" to mean any opening through which air and water can pass, then JJO's products do not infringe; if we interpret "openings" to mean openings defined by the courses and wales of the fabric, then JJO's products do infringe.

[12] To ascertain the true meaning of disputed claim language, resort should be made to the claims at issue, the specification, and the prosecution history. *C.R. Bard*, 911 F.2d at 673, 15 USPQ2d at 1543; *Loctite Corp. v. Ultraseal Ltd.*, 781 F.2d 861, 866-67, 228 USPQ 90, 93 (Fed. Cir. 1985). From the claim language itself we see that the inventor claims the number of "mesh size" openings per square inch and not merely the number of "openings" per square inch. The term "mesh," by definition, implies a coarseness or fineness of a grid or screen-like structure.

In addition, the Garwood patent compares the various fabrics in terms of "mesh number" and "mesh number openings/in<sup>2</sup>." The

We note that JJO included two sketches in its brief labeled PX-57 and PX-68 which JJO misrepresented as 3M's and JJO's respective fabrics. However, upon review of the record we find that these are not the true exhibits used at trial. PX-57 and PX-68 were, in reality, photographs magnifying the respective fabrics. After carefully comparing the actual photographic exhibits with the sketches, we find that JJO's sketches, especially PX-68, which exaggerates the relative size of the "openings" formed by the loops, misrepresents what is shown in the actual exhibits. JJO failed to inform this court that the sketches were not the actual exhibits or to explain, for example, that they were JJO's "reproduction" or "interpretation" of the photographs. Furthermore, when the misleading sketches were brought to the court's attention in respondent's brief, JJO failed to provide any explanation as to why they were not properly identified, let alone mislabeled.

Master's findings indicate that Table I in the Garwood patent, which lists several commercially available fabrics, sets forth their respective "mesh number openings" that, when examined, correspond with the number of openings calculated by multiplying the number of courses per inch by the number of wales per inch in the fabric. These findings are uncontested by JJO.

Our review of the prosecution history also reveals that Garwood, in addressing a rejection based on the Straube patent, extrapolated the number of mesh number openings in the Straube patent by multiplying the vertical members per inch by the horizontal members per inch. In addition, throughout the Garwood amendment Garwood equates "openings" with "mesh size" and "mesh number" using these interchangeably.

This interpretation of "mesh size" "openings" is also consistent with the prior art which teaches that mesh number openings are calculated based on courses and wales. Other evidence introduced at trial establishes that those skilled in the art understand that mesh size is measured by multiplying the number of wales by the number of courses and that, after reviewing the Garwood patent, they understood the use of the terms therein to be consistent with the ordinary usage of those terms. For example, the lab notebook of Mr. George Buese, a scientist at JJO and a person skilled in the casting art, together with related testimony indicate that prior to this litigation JJO reviewed the Garwood specification and compared claim 1 to the JJO products in an attempt to get around the claimed invention. The comparison and calculations made show that JJO understood that the mesh size is measured by multiplying the courses times the wales. Likewise, documents obtained from Mr. Burton Dahlen, a former research manager at Cutter and another person skilled in the casting art, together with his testimony establish that Cutter also reviewed the Garwood specification and understood that the number of mesh openings is determined by multiplying the number of courses per inch by the number of wales per inch.

Based on our review of the claims, the specification, the prosecution history, and the testimony of those skilled in the art we find that the evidence presented overwhelmingly supports 3M's interpretation of the claim. As previously mentioned, the proper interpretation to give to the claims is the only issue before us on review and, therefore, any further infringement analysis is unnecessary. Accordingly, we affirm the Master's finding of infringement.

### C. The Reed Patent

#### Inequitable Conduct

We have reviewed JJO's argument that the Reed patent is unenforceable based on 3M's intentional misrepresentation and omission of material facts in the Livermore and Racine affidavits submitted to overcome a PTO obviousness rejection. We have also reviewed the Master's extensive findings on this issue.

Inequitable conduct requires both a material misrepresentation or omission and an intent to mislead. See *Greenwood v. Hattori Seiko Co.*, 900 F.2d 238, 241-42, 14 USPQ2d 1474, 1476 (Fed. Cir. 1990). The Master, finding that JJO failed to prove either, determined that there was no inequitable conduct and that the patent is enforceable. JJO has failed to convince us that the Master abused her discretion on this issue.

### D. DAMAGES

[13] The issue of the amount of damages, where the damage award is fixed by the district court, is a question of fact and reviewed under the clearly erroneous standard. *SmithKline Diagnostics, Inc. v. Helena Lab., Corp.*, 926 F.2d 1161, 1164, 17 USPQ2d 1922, 1925 (Fed. Cir. 1991); 1 Steven A. Childress & Martha S. Davis, *Federal Standards of Review* § 2.22 (2d ed. 1992) (all circuits agree that the clearly erroneous rule applies to determinations of damages by the district court). However, certain subsidiary decisions underlying a damage theory (such as choosing between reasonable alternative accounting methods for determining profit margin or adopting a reasonable way to determine the number of infringing units) are discretionary with the court and, of course, are reviewed under the abuse of discretion standard. *Id.*

#### 1. Lost Profits Based On Lost Sales

To recover lost profits as actual damages, a patent holder must demonstrate that there was a reasonable probability that, but for the infringement, it would have made the infringer's sales. *State Indus., Inc. v. Mor-Flo Indus., Inc.*, 883 F.2d 1573, 1577, 12 USPQ2d 1026, 1028 (Fed. Cir. 1989), cert. denied, 110 S.Ct. 725 (1990). However, it is not necessary for the patent holder to negate all possibilities that a purchaser might have bought a different product or might have foregone the purchase altogether. *Id.* One way to prove lost profits is for the patent



holder to prove (1) demand for the patented product; (2) absence of acceptable noninfringing substitutes; (3) its manufacturing and marketing capability to exploit the demand; and (4) the amount of profit it would have made. *Id.* The existence of a noninfringing substitute is a question of fact, reviewable under the clearly erroneous standard. *Radio Steel & Mfg. Co. v. MTD Prods., Inc.*, 788 F.2d 1554, 1556, 229 USPQ 431, 432 (Fed. Cir. 1986).

JJO argues that the Master's award of lost profits for the Reed and Garwood inventions is based on an erroneous finding that there were no acceptable non-infringing substitutes available. JJO argues that it could have purchased (for resale) non-infringing alternatives to its Red Label and Improved Red Label products from Bayer in Germany because Bayer had a license under the Garwood and Reed patents<sup>10</sup> and had supplied JJO with similar type tapes in the past.

[14] The Master's findings indicate that although Bayer may have been entitled to manufacture casting tapes under the Garwood and Reed patents, it was unable to manufacture commercially acceptable casting tapes. Specifically, the Master found:

From the beginning of the period of infringement in September, 1985 through late 1990, Bayer was unable to manufacture casting tape which met JJO's product standards. JJO's own testing shows that Bayer-made product was unacceptable to JJO. Bayer did not supply JJO with commercially acceptable casting tape until several weeks before the trial, and that was admittedly done only for purposes of this litigation. There is no evidence in the record suggesting that JJO could have actually purchased a competitive casting tape from Bayer during the infringement period.

This finding is supported by JJO's own documents and witnesses.

JJO argues that the Master failed to consider all market influences when determining lost profits or reasonable royalty damages and alleges that she ignored the fact that JJO could have taught Bayer how to make acceptable products or given Bayer its machinery and personnel to enable it to make acceptable products. Had the Master considered this fact, JJO argues, she would

The Master's findings indicate that Bayer may possibly have had a license under the Reed patent. However, for the purposes of this opinion we will assume that JJO's representation of this fact is correct.

have found that a non-infringing alternative was available.

Based on the record, we are not convinced that the Master failed to consider this argument. The Master expressly recognized that JJO had "attempted to show that it would have maintained its own sales by importing licensed product from Bayer in Germany." JJO had the opportunity to proffer convincing rebuttal evidence on noninfringing substitutes and failed to do so. Therefore, based on the record before us, we conclude that JJO failed to establish that the Master's finding that there were no acceptable noninfringing alternatives with respect to the Reed and Garwood inventions was clearly erroneous.

[15] With respect to the Scholz patent, JJO argues that its Conformable (Blue Label) product with U-Thane resin is an acceptable, non-infringing substitute. We find the presentation of this argument to be frivolous. The only support for JJO's argument is its allegation that 3M failed to show that Blue Label with U-Thane was not a non-infringing substitute and, therefore, failed to carry its burden to show that no infringing alternative existed. However, there is no dispute that this issue was not considered at trial. In fact, JJO's brief expressly states that "Blue Label with U-Thane was never made part of this case." In light of these circumstances, JJO cannot expect this argument to be heard by this court when it was not raised at trial. *Weinar v. Rollform Inc.*, 744 F.2d 797, 804, 223 USPQ 369, 372-73 (Fed. Cir. 1984), cert. denied, 470 U.S. 1084 (1985).

## 2. Lost Profits Based On Price Erosion

The Master also awarded 3M \$28,923,219 in lost profits due to price erosion caused by JJO. The Master determined that 3M would have been able to increase its prices 2% per annum during the period of infringement if JJO had not been competing in the market. JJO argues that there is "not a shred" of evidence in the record to support the 2% figure and that the Master should not have awarded these damages. We disagree.

[16] The Master made several findings of fact indicating that, among other things, 3M and JJO engaged in vigorous price competition over equivalent products which caused a

Based on the 2% figure, 3M's lost profit would have been \$38,723,219. The Master, however, subtracted \$9.8 million which she determined would be the market contraction that would result from 3M's price increases, arriving at the final figure of \$28,923,219.

steady decline in the price of casting tape during the infringement period and 3M would have charged higher prices absent JJO's infringement. Although other companies also engaged in price competition, they had a small effect on the downward trend of prices because they offered inferior products and their market share continually declined over the course of the infringement period to the point where 3M and JJO together had approximately 85% of the market. The Master also found that 3M would have commanded 70-80% of the casting tape market with JJO gone and would have experienced little or no price competition from other competitors.

In addition, 3M's witnesses testified and presented documents to show that 3M would have raised prices approximately 4% per year to match the rate of inflation. 3M compared these figures with JJO's practice of raising prices 4% per year in the plaster casting market where JJO held a similar market share and had no patent protection.

JJO argued that there would have been zero inflation on synthetic casting tapes. After considering the evidence, the Master concluded that if JJO were not in the market, 3M could have and would have taken annual price increases of 2%. Although damages may not be based on speculation, they need not be proved with unerring precision either. *Bio-Rad Lab., Inc. v. Nicolet Inst. Corp.*, 739 F.2d 604, 616, 222 USPQ 654, 664 (Fed. Cir.), cert. denied, 469 U.S. 1038 (1984). The Master is not restricted from choosing a figure other than that advocated by either party and may substitute an intermediate figure as a matter of judgment from all the evidence. *SmithKline*, 926 F.2d at 1168, 17 USPQ2d at 1927. We find that the Master's decision to award the 2% increment rate based on all the evidence was not clearly erroneous.

### 3. Computational Errors

JJO alleges that the Master committed some computational errors which the district court failed to correct. Although an arithmetical error would be a clear error of fact, JJO has failed to convince us that such errors were made.

[17] JJO's argument relies on FF 391 wherein the Master, comparing the cost analyses presented by JJO's and 3M's respective experts, found that under the circumstances of this case "Hoffman's (JJO's

expert) cost analysis is accurate and creditable." (Emphasis ours.) In the same finding, the Master says, "Production of the additional units claimed by 3M would have resulted in increased costs in an amount \$10 million over and above those costs estimated by 3M." (Emphasis ours.) JJO then cites to a chart prepared by Mr. Hoffman, entitled "Impact Of Incremental Costs Errors" (Def. Ex. 844), which indicates that, based on an increased volume of 10,226,245 units, 3M's increased costs would amount to \$13,074,334 over and above the costs estimated by 3M. Based on this information, JJO contends that the Master misread the chart and erroneously took the Unit Volume (i.e., 10,226,245 units) in place of the Magnitude of Error in dollars (i.e., \$13,074,334 in additional production costs) in arriving at the \$10 million figure.

JJO's argument is based on the presumption that there is no other explanation to explain how the Master arrived at the \$10 million figure. However, using a different method of calculation, 3M's expert, Mr. Troxel, estimated that additional production costs would amount to \$7,272,908. Although the Master credited JJO's cost analysis, she also found that "[b]oth methods present an acceptable basis for estimating variable costs" although "3M has understated the amount of increased costs it would have incurred by its increased sales." As previously stated, the Master may choose a figure other than that advocated by either party. *Id.* Here, as she did in determining the price erosion percentage, the Master split the difference between the two estimates advocated by JJO's and 3M's experts rounding it off to \$10 million. We hold that the Master's decision to adjust the two estimates provided by 3M and JJO to reflect her assessment of what the increased production costs would be is not clearly erroneous.

### E. Willful Infringement of the Reed and Scholz Patents

[18] The question of whether infringement is willful is one of fact and, as such, is reviewable under the clearly erroneous standard. *Ryco, Inc. v. Ag-Bag Corp.*, 857 F.2d 1418, 1428, 8 USPQ2d 1323, 1334 (Fed. Cir. 1988); *Bott v. Four Star Corp.*, 807 F.2d 1567, 1572, 1 USPQ2d 1210, 1213 (Fed. Cir. 1986). JJO presents three primary arguments with respect to this issue. First, JJO alleges that the Master applied an erro-

neous legal standard. JJO willfully infringed patents. Second, Scholz and Reed had a reasonable in-house counsel who were invalid with respect to that the Master's determination of 3M's

### 1. The Proper Standard

JJO's first argument is that the Master applied the wrong legal standard. The correct legal standard is that the Master's

A court must determine the circumstances would prudent confidence in a patent invalid. More important, the Master's opinion she considered case before an argument focus one sentence "what the Master's analysis is. Finally, the Master and considered by the district Master's conclusion the record, we Master or the proper standard

### 2. Reliability

[19] It is well known that an infringer having intent has an affirmative defense normally requiring obtaining competent evidence or continuing at 1428, 8 USPQ2d advice is only an opinion against a finding

"JJO argues that the Master's decision indicates that the standard of review is 'clearly erroneous.' Here, JJO has a court would rule that JJO added.) The district court language, which of the correct Ryco and did burden of proof

neous legal standard in determining that JJO willfully infringed the Scholz and Reed patents. Second, with respect to both the Scholz and Reed patents, JJO argues that it had a reasonable basis (i.e., the opinion of its in-house counsel) to believe that the patents were invalid and unenforceable. Finally, with respect to the Scholz patent, JJO argues that the Master erroneously based her willfulness determination on JJO's misappropriation of 3M's trade secrets.

### 1. The Proper Legal Standard

JJO's first argument is not supported by the record. The Master accurately laid out the correct legal standard expressly quoting this court's language in *Ryco, Inc.*:

"A court must look at whether 'under all the circumstances, a reasonable person would prudently conduct himself with any confidence that a court might hold the patent invalid or not infringed.'"

More importantly, we are convinced by the Master's opinion and findings of fact that she considered all the circumstances in this case before arriving at her decision. JJO's argument focuses on what the Master says in one sentence "instead of on the totality of what the Master actually did as evidenced by her analysis and detailed list of findings. Finally, the Master's findings were reviewed and considered, in light of JJO's argument, by the district court which then adopted the Master's conclusion. Based on our review of the record, we are not convinced that the Master or the district court applied an improper standard of review.

### 2. Reliability of JJO's In-House Opinion

[19] It is well settled that a potential infringer having actual notice of another's patent has an affirmative duty of due care that normally requires the potential infringer to obtain competent legal advice before infringing or continuing to infringe. *Ryco*, 857 F.2d at 1428, 8 USPQ2d at 1332. However, legal advice is only one factor to be considered, and an opinion of counsel does not guarantee against a finding of willfulness. *Id.*, see *Un-*

*derwater Devices*, 717 F.2d at 1390, 219 USPQ at 576; *Datascope*, 879 F.2d at 828, 11 USPQ2d at 1327. The emphasis here must be on "competent" legal advice. JJO obtained legal advice from its in-house counsel, Michael Tatlow, in the form of an oral opinion. As this court has recognized, oral opinions are not favored. *Shiley, Inc. v. Bentley Lab., Inc.*, 601 F. Supp. 964, 968, 225 USPQ 1013, 1016 (C.D. Cal. 1985), *aff'd*, 794 F.2d 1561, 230 USPQ 112 (Fed. Cir. 1986); *Bott*, 807 F.2d at 1572, 1 USPQ2d at 1213. Such opinions carry less weight, for example, because they have to be proved perhaps years after the event, based only on testimony which may be affected by faded memories and the forces of contemporaneous litigation.

Furthermore, the Master determined that JJO had no reasonable basis to rely on Tatlow's oral opinion because, at a minimum, it was not objective. Tatlow opined that (1) the Reed patent was invalid because the process of heat setting without tension had been known and practiced by Carolina Narrows Fabric (CNF), JJO's fabric supplier, for years and (2) the technique of heat setting without tension was taught in U.S. Patent No. 2,633,428, issued to Klug in March, 1953 (the Klug patent). However, Tatlow obtained his information that heat setting without tension had been practiced for years, not from an independent expert, but from the president of CNF who had a stake in the outcome.

The Master further found that JJO knew the information was false for at least two reasons. First, JJO knew CNF was unable to produce an extensible fabric without frayed ends, because JJO had repeatedly asked CNF to produce such a fabric and had documented CNF's inability to do so. Second, three months after 3M's Scotchcast 2 came on the market, it was JJO's scientist who discovered its secret and provided this information to CNF.

Similarly, CNF had provided the Klug patent to Tatlow with an explanation that it taught heat setting without tension. However, the Master found that the patent is directed toward woven glass fabrics, and the continuous nature of the process shows that the fabric is under sufficient tension to distort knit fiberglass loops. The Master also found that nothing in Klug suggests that the process will produce an extensible heat set knit fiberglass fabric and that JJO did not seek an opinion from outside patent counsel evaluating the effect of Klug on Reed before deciding to infringe the Reed patent.

In January, 1987, Tatlow also informed the management of JJO that the Reed patent

JJO argues that the emphasized language indicates that the Master applied the wrong standard of review in determining willfulness:

"Here, JJO had no reason to be confident that a court would hold the Reed patent invalid, or rule that JJO did not infringe." (Emphasis added.)

The district court found that the paraphrased language, which followed the Master's recitation of the correct standard, was within the spirit of *Ryco* and did not place an erroneously high burden of proof on JJO.

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was unenforceable because 3M's Livermore and Racine affidavits were filed with the intent to mislead the PTO with false information. JJO's argument that it had a reasonable basis to believe that the Racine and Livermore affidavits contained fraudulent information was also found to be unreasonable by the Master. With respect to the Racine affidavit, JJO knew that the substance of the commercial success information was true because JJO was copying the Reed invention in its Improved Red Label product, which was also experiencing commercial success. With respect to the Livermore affidavit, the Master found that JJO had no reasonable basis to dispute the substance of the affidavit that the standard process in the prior art for producing fiberglass substrates was through heat setting under tension.

As the Master indicated, "JJO chose to ignore facts long in its possession, and instead rely on facially unreasonable claims from its fabric supplier, to justify infringement." As this court warned in *Ryco*, "[a]n alleged infringer who intentionally blinds himself to the facts and law, continues to infringe, and employs the judicial process with no solidly based expectation of success, can hardly be surprised when his infringement is found to have been willful." 857 F.2d at 1429, 8 USPQ2d at 1332.

### 3. Reliance on JJO's Trade Secret Misappropriation

JJO seems to imply that the Master erroneously based her willful infringement finding solely on JJO's trade secret theft which occurred *before* the issuance of the Scholz patent. This argument is not supported by the record.

[20] Although the Master based her willful infringement finding on JJO's conduct surrounding its misappropriation of 3M's trade secrets, her reliance thereon was just one of the criteria used to make her determination. Such considerations are completely proper. When determining whether infringing conduct warrants a finding of willfulness the court must examine the totality of the circumstances of the case. *Kaufman Co. v. Lantech, Inc.*, 807 F.2d 970, 978-79, 1 USPQ2d 1202, 1208 (Fed. Cir. 1986); *Kloster Speedsteel AB v. Crucible, Inc.*, 793 F.2d 1565, 1579, 230 USPQ 81, 90 (Fed. Cir. 1986), *cert. denied*, 479 U.S. 1034 (1987). In addition, although willfulness is generally based on conduct that occurred after a patent issued, pre-patent conduct may also be used to support a finding of willfulness. See *Kaufman*, 807 F.2d at 978-79, 1 USPQ2d at 1208.

As the Master found, Tatlow was involved with the misappropriation of the 3M trade secrets and was copied on the internal JJO memorandum which disclosed that JJO researchers had figured out the 3M trade secret in the samples stolen by Stegora. He also prepared and prosecuted JJO's patent application on the slippery resin product which was based on the misappropriated 3M technology. The fact that JJO, with the help of its in-house attorney, Tatlow, would attempt to patent the stolen technology makes Tatlow's opinion suspect. It is doubtful that Tatlow could have the requisite impartiality to objectively evaluate the Scholz patent. *H.B. Fuller Co. v. National Starch and Chem. Corp.*, 689 F. Supp. 923, 952, 7 USPQ2d 1753, 1775-76 (D. Minn. 1988). Furthermore, the Master found that the positions Tatlow allegedly adopted in his oral opinion regarding the tacky prior art with respect to the Scholz patent were inconsistent with positions he took on that art in prosecuting the JJO application.

Finally, many other findings support the Master's willfulness determination including JJO's full appreciation of the commercial significance of the Scholz patent and the technological improvement of its described inventions over the prior art. *Spindelfabrik Suessen-Schurr Stahlecker & Grill, GmbH v. Schubert & Salzer Maschinenfabrik Aktiengesellschaft*, 829 F.2d 1075, 1083, 4 USPQ2d 1044, 1050-51 (Fed. Cir. 1987), *cert. denied*, 484 U.S. 1063 (1988). JJO's knowledge that it had wrongfully acquired and misappropriated the Scholz invention and that its products were derived from 3M's technology. *Colgate-Palmolive Co. v. Carter Prods.*, 230 F.2d 855, 866, 108 USPQ 383, 391 (4th Cir.), *cert. denied*, 352 U.S. 843 [111 USPQ 467] (1956). JJO's pattern of copying 3M innovations in each synthetic casting product in order to remain competitive in the market. *State Indus.*, 883 F.2d at 1582, 12 USPQ2d at 1032, and the intense business and technical rivalry between JJO and 3M. In such circumstances due care may require the opinion of outside counsel.<sup>13</sup> *H.B.*

<sup>13</sup> JJO argues that the Master's finding of willfulness was erroneous because JJO did obtain an outside opinion. However, the opinion obtained was from JJO's outside trial counsel in June 1988 — twenty-one months after the Reed patent issued and thirteen months after the Scholz patent issued. The Master found that this opinion was a case analysis prepared by outside counsel representing JJO in this lawsuit and as such is inherently suspect. The case analysis states that if the Reed and Scholz patents are valid, then JJO infringes. With respect to the invalidity of the Reed patent, the Master found



Fuller, 689 F. Supp. at 952, 7 USPQ2d at 1775-76.

The Master's decision that JJO willfully infringed the Reed and Scholz patents without any good faith belief that the patents were either invalid or unenforceable is supported by the record. After reviewing all of JJO's arguments, we are left unconvinced that the Master's willfulness determination was clearly erroneous. Likewise, JJO has failed to convince us that the Master abused her discretion in doubling the damages.

### III. CONCLUSION

Accordingly, the judgment of the district court is affirmed.

### AFFIRMED

District Court, C.D. Illinois

Brandt Consolidated Inc. v. Agrimar Corp.

No. 91-3364

Decided August 13, 1992

### JUDICIAL PRACTICE AND PROCEDURE

#### 1. Jurisdiction — Venue; transfer of action — In patent actions (§405.1907)

##### Procedure — Stays — In general (§410.2901)

Transfer of action filed in federal district court in Illinois, seeking declaratory judgment of non-infringement, to federal district court in Florida, considering declaratory judgment defendant's subsequently-filed patent infringement action and motion to hold plaintiff in contempt for violating earlier injunction is not warranted, nor should declaratory judgment action be stayed, since contempt motion has been denied and thus Florida court's priority jurisdiction has been terminated, and, since declaratory judgment action was filed prior to infringement action, any potential comity problems should be addressed to Florida court.

that the case analysis relied exclusively on CNF's unsubstantiated claims of prior use; and, the fact that JJO failed to inform outside counsel of the facts in its possession (i.e., that CNF did not previously practice the invention) limits JJO's ability to rely on the case analysis.

#### 2. Jurisdiction — Personal jurisdiction (§405.11)

Federal district court in Illinois has personal jurisdiction, in action seeking declaratory judgment of non-infringement, over French company which is parent corporation of U.S. subsidiary that holds exclusive license to produce algae extract under patent in suit, since French company was party to sending infringement letters in Illinois and also purposely availed itself of business relationship with plaintiff, which is Illinois corporation, and, since jurisdiction-triggering activities of its subsidiary, which is not independent corporation but functions only as division of French company, can be attributed to parent.

### PATENTS

#### 3. Infringement — Defenses — In general (§120.1101)

35 USC 271(g), which provides that anyone who imports, sells, or uses product made by process patented in U.S. shall be liable as infringer, does not apply to plaintiff, in view of evidence demonstrating that its entire inventory of agricultural foliar nutritional spray, allegedly made pursuant to patent in suit, was imported into U.S. prior to section's effective date, and even if such section did apply, plaintiff would be protected by its "grandfather clause," applicable to use, sale, or importation of any specific product already in substantial and continuous sale or use by Jan. 1, 1988; thus, applying pre-271(g) patent law, plaintiff cannot be held liable for patent infringement for its use of spray sold to it by defendants, since defendants, once they sold product to plaintiff, lost any ability to control use of that product pursuant to their patent monopoly.

### TRADEMARKS AND UNFAIR TRADE PRACTICES

#### 4. Infringement; conflicts between marks — Passing off (§335.07)

##### Unfair and false advertising — Lanham Act Section 43(a) (§390.05)

##### Unfair competition — In general (§395.01)

Action under Lanham Act's Section 43(a), 15 USC 1125(a), unlike common law action for unfair competition, does not require showing of bad faith or intent to deceive; thus, defendant's material false representations as to scope of their patent, which were likely to deceive third party into believing that plaintiff's products infringed such patent, violated Section 43(a), regardless of

*re Piasecki*, 745 F.2d 1468, 223 USPQ 785 (Fed. Cir. 1984) for a detailed discussion of the proper roles of the examiner's *prima facie* case and applicant's rebuttal evidence in the final determination of obviousness.

If, after evaluating the evidence, the examiner is still not convinced that the claimed invention is patentable, the next Office action should include a statement to that effect and identify the reason(s) (e.g., evidence of commercial success not convincing, the commercial success not related to the technology, etc.). See *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 7 USPQ2d 1222 (Fed. Cir.), *cert. denied*, 488 U.S. 956 (1988). See also MPEP § 716.01. See MPEP § 2144.08, paragraph II.B., for guidance in determining whether rebuttal evidence is sufficient to overcome a *prima facie* case of obviousness.

## 716.02 Allegations of Unexpected Results

Any differences between the claimed invention and the prior art may be expected to result in some differences in properties. The issue is whether the properties differ to such an extent that the difference is really unexpected. In *re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986) (differences in sedative and anticholinergic effects between prior art and claimed antidepressants were not unexpected). In *re Waymouth*, 499 F.2d 1273, 1276, 182 USPQ 290, 293 (CCPA 1974), the court held that unexpected results for a claimed range as compared with the range disclosed in the prior art had been shown by a demonstration of "a marked improvement, over the results achieved under other ratios, as to be classified as a difference in kind, rather than one of degree." Compare *In re Wagner*, 371 F.2d 877, 884, 152 USPQ 552, 560 (CCPA 1967) (differences in properties cannot be disregarded on the ground they are differences in degree rather than in kind); *Ex parte Gelles*, 22 USPQ2d 1318, 1319 (Bd. Pat. App. & Inter. 1992) ("we generally consider a discussion of results in terms of 'differences in degree' as compared to 'differences in kind' . . . to have very little meaning in a relevant legal sense").

## 716.02(a) Evidence Must Show Unexpected Results [R-2]

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### I. < GREATER THAN EXPECTED RESULTS ARE EVIDENCE OF NONOBVIOUSNESS

"A greater than expected result is an evidentiary factor pertinent to the legal conclusion of obviousness . . . of the claims at issue." In *re Corkill*, 711 F.2d 1496, 226 USPQ 1005 (Fed. Cir. 1985). In *Corkill*, the claimed combination showed an additive result when a diminished result would have been expected. This result was persuasive of nonobviousness even though the result was equal to that of one component alone. Evidence of a greater than expected result may also be shown by demonstrating an effect which is greater than the sum of each of the effects taken separately (i.e., demonstrating "synergism"). *Merck & Co. Inc. v. Biocraft Laboratories Inc.*, 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), *cert. denied*, 493 U.S. 975 (1989). However, a greater than additive effect is not necessarily sufficient to overcome a *prima facie* case of obviousness because such an effect can either be expected or unexpected. Applicants must further show that the results were greater than those which would have been expected from the prior art to an unobvious extent, and that the results are of a significant, practical advantage. *Ex parte The NutraSweet Co.*, 19 USPQ2d 1586 (Bd. Pat. App. & Inter. 1991) (Evidence showing greater than additive sweetness resulting from the claimed mixture of saccharin and L-aspartyl-L-phenylalanine was not sufficient to outweigh the evidence of obviousness because the teachings of the prior art lead to a general expectation of greater than additive sweetening effects when using mixtures of synthetic sweeteners.).

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### II. < SUPERIORITY OF A PROPERTY SHARED WITH THE PRIOR ART IS EVIDENCE OF NONOBVIOUSNESS

Evidence of unobvious or unexpected advantageous properties, such as superiority in a property the claimed compound shares with the prior art, can rebut *prima facie* obviousness. "Evidence that a compound is unexpectedly superior in one of a spectrum of common properties . . . can be enough to rebut a *prima*

*facie* case of obviousness." No set number of examples of superiority is required. *In re Chupp*, 816 F.2d 643, 646, 2 USPQ2d 1437, 1439 (Fed. Cir. 1987) (Evidence showing that the claimed herbicidal compound was more effective than the closest prior art compound in controlling quackgrass and yellow nutsedge weeds in corn and soybean crops was sufficient to overcome the rejection under 35 U.S.C. 103, even though the specification indicated the claimed compound was an average performer on crops other than corn and soybean.). See also *Ex parte A*, 17 USPQ2d 1716 (Bd. Pat. App. & Inter. 1990) (unexpected superior therapeutic activity of claimed compound against anaerobic bacteria was sufficient to rebut *prima facie* obviousness even though there was no evidence that the compound was effective against all bacteria).

### III. < PRESENCE OF AN UNEXPECTED PROPERTY IS EVIDENCE OF NONOBVIOUSNESS

Presence of a property not possessed by the prior art is evidence of nonobviousness. *In re Papesch*, 315 F.2d 381, 137 USPQ 43 (CCPA 1963) (rejection of claims to compound structurally similar to the prior art compound was reversed because claimed compound unexpectedly possessed anti-inflammatory properties not possessed by the prior art compound); *Ex parte Thumm*, 132 USPQ 66 (Bd. App. 1961) (Appellant showed that the claimed range of ethylene diamine was effective for the purpose of producing "regenerated cellulose consisting substantially entirely of skin" whereas the prior art warned "this compound has 'practically no effect.'"). The submission of evidence that a new product possesses unexpected properties does not necessarily require a conclusion that the claimed invention is nonobvious. *In re Payne*, 606 F.2d 303, 203 USPQ 245 (CCPA 1979). See the discussion of latent properties and additional advantages in MPEP § 2145.

### IV. < ABSENCE OF AN EXPECTED PROPERTY IS EVIDENCE OF NONOBVIOUSNESS

Absence of property which a claimed invention would have been expected to possess based on the

teachings of the prior art is evidence of unobviousness. *Ex parte Mead Johnson & Co.* 227 USPQ 78 (Bd. Pat. App. & Inter. 1985) (Based on prior art disclosures, claimed compounds would have been expected to possess beta-andrenergic blocking activity; the fact that claimed compounds did not possess such activity was an unexpected result sufficient to establish unobviousness within the meaning of 35 U.S.C. 103.).

### 716.02(b) Burden on Applicant [R-2]

#### I. < BURDEN ON APPLICANT TO ESTABLISH RESULTS ARE UNEXPECTED AND SIGNIFICANT

The evidence relied \*>upon< should establish "that the differences in results are in fact unexpected and unobvious and of both statistical and practical significance." *Ex parte Gelles*, 22 USPQ2d 1318, 1319 (Bd. Pat. App. & Inter. 1992) (Mere conclusions in appellants' brief that the claimed polymer had an unexpectedly increased impact strength "are not entitled to the weight of conclusions accompanying the evidence, either in the specification or in a declaration."); *Ex parte C*, 27 USPQ2d 1492 (Bd. Pat. App. & Inter. 1992) (Applicant alleged unexpected results with regard to the claimed soybean plant, however there was no basis for judging the practical significance of data with regard to maturity date, flowering date, flower color, or height of the plant.). See also *In re Nolan*, 553 F.2d 1261, 1267, 193 USPQ 641, 645 (CCPA 1977) and *In re Eli Lilly*, 902 F.2d 943, 14 USPQ2d 1741 (Fed. Cir. 1990) as discussed in MPEP § 716.02(c).

#### II. < APPLICANTS HAVE BURDEN OF EXPLAINING PROFFERED DATA

"[A]ppellants have the burden of explaining the data in any declaration they proffer as evidence of non-obviousness." *Ex parte Ishizaka*, 24 USPQ2d 1621, 1624 (Bd. Pat. App. & Inter. 1992).

molecular weights in excess of 12,000 to homogeneity wherein the prior art method was similar to the method disclosed by appellant for purifying interleukin 2.).

Compare *Ex parte Gray*, 10 USPQ2d 1922 (Bd. Pat. App. & Inter. 1989) (Claims were directed to human nerve growth factor b-NGF free from other proteins of human origin, and the specification disclosed making the claimed factor through the use of recombinant DNA technology. The claims were rejected as *prima facie* obvious in view of two references disclosing b-NGF isolated from human placental tissue. The Board applied case law pertinent to product-by-process claims, reasoning that the prior art factor appeared to differ from the claimed factor only in the method of obtaining the factor. The Board held that the burden of persuasion was on appellant to show that the claimed product exhibited unexpected properties compared with that of the prior art. The Board further noted that “no objective evidence has been provided establishing that no method was known to those skilled in this field whereby the claimed material might have been synthesized.” 10 USPQ2d at 1926.).

## 2144.05 Obviousness of Ranges [R-3]

See MPEP § 2131.03 for case law pertaining to rejections based on the anticipation of ranges under 35 U.S.C. 102 and 35 U.S.C. 102/103.

### I. OVERLAP OF RANGES

In the case where the claimed ranges “overlap or lie inside ranges disclosed by the prior art” a *prima facie* case of obviousness exists. *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990) (The prior art taught carbon monoxide concentrations of “about 1-5%” while the claim was limited to “more than 5%.” The court held that “about 1-5%” allowed for concentrations slightly above 5% thus the ranges overlapped.); *In re Geisler*, 116 F.3d 1465, 1469-71, 43 USPQ2d 1362, 1365-66 (Fed. Cir. 1997) (Claim reciting thickness of a protective layer as falling within a range of “50 to 100 Angstroms” considered *prima facie* obvious in view of prior art reference teaching that “for suitable protection, the thickness of the protective layer should be not less than about 10 nm [i.e., 100 Angstroms].” The court stated that “by

stating that ‘suitable protection’ is provided if the protective layer is ‘about’ 100 Angstroms thick, [the prior art reference] directly teaches the use of a thickness within [applicant’s] claimed range.”). Similarly, a *prima facie* case of obviousness exists where the claimed ranges and prior art ranges do not overlap but are close enough that one skilled in the art would have expected them to have the same properties. *Titanium Metals Corp. of America v. Banner*, 778 F.2d 775, 227 USPQ 773 (Fed. Cir. 1985) (Court held as proper a rejection of a claim directed to an alloy of “having 0.8% nickel, 0.3% molybdenum, up to 0.1% iron, balance titanium” as obvious over a reference disclosing alloys of 0.75% nickel, 0.25% molybdenum, balance titanium and 0.94% nickel, 0.31% molybdenum, balance titanium.).

“[A] prior art reference that discloses a range encompassing a somewhat narrower claimed range is sufficient to establish a *prima facie* case of obviousness.” *In re Peterson*, 315 F.3d 1325, 1330, 65 USPQ2d 1379, 1382-83 (Fed. Cir. 2003). However, if the reference’s disclosed range is so broad as to encompass a very large number of possible distinct compositions, this might present a situation analogous to the obviousness of a species when the prior art broadly discloses a genus. *Id.* See also *In re Baird*, 16 F.3d 380, 29 USPQ2d 1550 (Fed. Cir. 1994); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992); MPEP § 2144.08.

>A range can be disclosed in multiple prior art references instead of in a single prior art reference depending on the specific facts of the case. *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1322, 73 USPQ2d 1225, 1228 (Fed. Cir. 2004). The patent claim at issue was directed to a weight plate having 3 elongated openings that served as handles for transporting the weight plate. Multiple prior art patents each disclosed weight plates having 1, 2 or 4 elongated openings. 392 F.3d at 1319, 73 USPQ2d at 1226. The court stated that the claimed weight plate having 3 elongated openings fell within the “range” of the prior art and was thus presumed obvious. 392 F.3d at 1322, 73 USPQ2d at 1228. The court further stated that the “range” disclosed in multiple prior art patents is “a distinction without a difference” from previous range cases which involved a range disclosed in a single patent since the “prior art suggested that a larger number of elongated grips in the weight plates was—



beneficial... thus plainly suggesting that one skilled in the art look to the range appearing in the prior art." *Id.*<

## II. OPTIMIZATION OF RANGES

### A. Optimization Within Prior Art Conditions or Through Routine Experimentation

Generally, differences in concentration or temperature will not support the patentability of subject matter encompassed by the prior art unless there is evidence indicating such concentration or temperature is critical. "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA 1955) (Claimed process which was performed at a temperature between 40°C and 80°C and an acid concentration between 25% and 70% was held to be *prima facie* obvious over a reference process which differed from the claims only in that the reference process was performed at a temperature of 100°C and an acid concentration of 10%.); see also *Peterson*, 315 F.3d at 1330, 65 USPQ2d at 1382 ("The normal desire of scientists or artisans to improve upon what is already generally known provides the motivation to determine where in a disclosed set of percentage ranges is the optimum combination of percentages."); *In re Hoeschele*, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969) (Claimed elastomeric polyurethanes which fell within the broad scope of the references were held to be unpatentable thereover because, among other reasons, there was no evidence of the criticality of the claimed ranges of molecular weight or molar proportions.). For more recent cases applying this principle, see *Merck & Co. Inc. v. Biocraft Laboratories Inc.*, 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), *cert. denied*, 493 U.S. 975 (1989); *In re Kulling*, 897 F.2d 1147, 14 USPQ2d 1056 (Fed. Cir. 1990); and *In re Geisler*, 116 F.3d 1465, 43 USPQ2d 1362 (Fed. Cir. 1997).

### B. Only Result-Effective Variables Can Be Optimized

A particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable

might be characterized as routine experimentation. *In re Antonie*, 559 F.2d 618, 195 USPQ 6 (CCPA 1977) (The claimed wastewater treatment device had a tank volume to contractor area of 0.12 gal./sq. ft. The prior art did not recognize that treatment capacity is a function of the tank volume to contractor ratio, and therefore the parameter optimized was not recognized in the art to be a result-effective variable.). See also *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980) (prior art suggested proportional balancing to achieve desired results in the formation of an alloy).

## III. REBUTTAL OF PRIMA FACIE CASE OF OBVIOUSNESS

Applicants can rebut a *prima facie* case of obviousness based on overlapping ranges by showing the criticality of the claimed range. "The law is replete with cases in which the difference between the claimed invention and the prior art is some range or other variable within the claims. . . . In such a situation, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range." *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990). See MPEP § 716.02 - § 716.02(g) for a discussion of criticality and unexpected results.

A *prima facie* case of obviousness may also be rebutted by showing that the art, in any material respect, teaches away from the claimed invention. *In re Geisler*, 116 F.3d 1465, 43 USPQ2d 1362, 1366 (Fed. Cir. 1997) (Applicant argued that the prior art taught away from use of a protective layer for a reflective article having a thickness within the claimed range of "50 to 100 Angstroms." Specifically, a patent to Zehender, which was relied upon to reject applicant's claim, included a statement that the thickness of the protective layer "should be not less than about [100 Angstroms]." The court held that the patent did not teach away from the claimed invention. "Zehender suggests that there are benefits to be derived from keeping the protective layer as thin as possible, consistent with achieving adequate protection. A thinner coating reduces light absorption and minimizes manufacturing time and expense. Thus, while Zehender expresses a preference for a thicker protective layer of 200-300 Angstroms, at the same

time it provides the motivation for one of ordinary skill in the art to focus on thickness levels at the bottom of Zehender's 'suitable' range- about 100 Angstroms- and to explore thickness levels below that range. The statement in Zehender that '[i]n general, the thickness of the protective layer should be not less than about [100 Angstroms]' falls far short of the kind of teaching that would discourage one of skill in the art from fabricating a protective layer of 100 Angstroms or less. [W]e are therefore 'not convinced that there was a sufficient teaching away in the art to overcome [the] strong case of obviousness' made out by Zehender."). See MPEP § 2145, paragraph X.D., for a discussion of "teaching away" references.

>Applicant can rebut a presumption of obviousness based on a claimed invention that falls within a prior art range by showing "(1) [t]hat the prior art taught away from the claimed invention...or (2) that there are new and unexpected results relative to the prior art." *Iron Grip Barbell Co., Inc. v. USA Sports, Inc.*, 392 F.3d 1317, 1322, 73 USPQ2d 1225, 1228 (Fed. Cir. 2004). The court found that patentee offered neither evidence of teaching away of the prior art nor new and unexpected results of the claimed invention drawn to a weight plate having 3 elongated handle openings. 392 F.3d at 1323, 73 USPQ2d at 1229. The court then turned to considering substantial evidence of pertinent secondary factors such as commercial success, satisfaction of a long-felt need, and copying by others may also support patentability. *Id.* Nevertheless, the court found that *Iron Grip* failed to show evidence of commercial success, copying by others, or satisfaction of a long felt need for the following reasons: (A) *Iron Grip's* licensing of its patent to three competitors was insufficient to show nexus between the "merits of the invention and the licenses," and thus did not establish secondary consideration of commercial success; (B) in response to *Iron Grip's* argument that the competitor's production of a three-hole plate is evidence of copying, the court stated that "[n]ot every competing product that falls within the scope of a patent is evidence of copying" since "[o]therwise every infringement suit would automatically confirm the nonobviousness of the patent;" and (C) although *Iron Grip* offered as evidence that the absence of the three-grip plate on the market prior to its patent showed that the invention was nonobviousness, the court stated that "[a]bsent a showing of a

long-felt need or the failure of others, the mere passage of time without the claimed invention is not evidence of nonobviousness." 392 F.3d at 1324-25, 73 USPQ2d at 1229-30.<

## 2144.06 Art Recognized Equivalence for the Same Purpose

### COMBINING EQUIVALENTS KNOWN FOR THE SAME PURPOSE

"It is *prima facie* obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition to be used for the very same purpose.... [T]he idea of combining them flows logically from their having been individually taught in the prior art." *In re Kerkhoven*, 626 F.2d 846, 850, 205 USPQ 1069, 1072 (CCPA 1980) (citations omitted) (Claims to a process of preparing a spray-dried detergent by mixing together two conventional spray-dried detergents were held to be *prima facie* obvious.). See also *In re Crockett*, 279 F.2d 274, 126 USPQ 186 (CCPA 1960) (Claims directed to a method and material for treating cast iron using a mixture comprising calcium carbide and magnesium oxide were held unpatentable over prior art disclosures that the aforementioned components individually promote the formation of a nodular structure in cast iron.); and *Ex parte Quadranti*, 25 USPQ2d 1071 (Bd. Pat. App. & Inter. 1992) (mixture of two known herbicides held *prima facie* obvious). But see *In re Geiger*, 815 F.2d 686, 2 USPQ2d 1276 (Fed. Cir. 1987) ("Based upon the prior art and the fact that each of the three components of the composition used in the claimed method is conventionally employed in the art for treating cooling water systems, the board held that it would have been *prima facie* obvious, within the meaning of 35 U.S.C. 103, to employ these components in combination for their known functions and to optimize the amount of each additive.... Appellant argues... hindsight reconstruction or at best, 'obvious to try'.... We agree with appellant.").

### SUBSTITUTING EQUIVALENTS KNOWN FOR THE SAME PURPOSE

In order to rely on equivalence as a rationale supporting an obviousness rejection, the equivalency must be recognized in the prior art, and cannot be

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